JUL 13 1935

ngineering
ibrary

Engineering News-Record

McGraw-Hill Publishing Company, Inc. July 11, 1935 Twenty-five Cents, Five Dollars per year

New
son Sinking
Method

•

efabricated
House
Examples

•

Concrete
nnel Lining
Continuous
ddle Mixer

Rotating Caissons Drill Their Way to Rock on Site of New York City Post Office

Report of
A.S.T.M.
Meeting—II

•

Extending
Owens Valley
Aqueduct

•

Moisture
In Aggregates
Measured
By Electricity

This Byers Dragline, powered by a "Caterpillar" Diesel Engine, is building an irrigation ditch at a fuel cost of less than 50c per 8-hour shift.

Like more than 30 other machinery manufacturers, the Byers Machine Company, of Ravenna, Ohio, was quick to take advantage of the dependability, versatility, and amazing economy that feature "Caterpillar" Diesel Engines. The SHOW-DOWN performance of this rugged power plant is passed on to Byers customers in shovels, draglines, and cranes from ⅜ to 1¼ cu. yd. capacity. Ask about the facts and figures that make "Caterpillar" Diesel power big news. Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR
D. E. S. L.

A RETURN to REASON

THIS is written within a few hours of the President's statement distinguishing between public works projects to be handled by the Public Works Administration and work-relief jobs to be created by the Works Progress Administration. It is written also in the light of authoritative information as to present intentions with respect to the work-relief program.

These finally recognize facts that are palpable to all who understand the conditions under which the construction end of any work-relief programs must function. They are an encouraging indication of a trend toward sober second thought. So let us have a look at their significance and see what changes they may suggest in the objectives of the construction industry. For it is clear that this progress does not lessen the need for a unified industry effort; it simply suggests a revision of its objectives.

The net of the situation is that for the first time a line has been drawn between useful public works to be built by the PWA and work-relief jobs to be made by Mr. Hopkins' WPA. The former include all the major public works and housing projects, costing more than $25,000, that do not come under the jurisdiction of regular federal departments. The latter include projects of less cost and, in addition, certain "made-work" jobs, of whatever cost.

THIS segregation materially reduces the danger of work-relief methods undermining the normal public works program, because in the conduct of PWA projects normal methods will prevail. Jobs ordinarily done by contract will be so handled. Labor will be drawn from relief rolls but it will be paid prevailing wages and be hired directly by the contractors. On WPA jobs "security wages" will apply, and as many projects as possible will be handled through some form of contract for management only. Materials and equipment for contract work will be purchased directly by the contractors while those for the work-relief jobs will be bought through regional or local agencies.

So far as concerns the individual project, the impractical $1100 to $1400 per-man-per-year requirement is out. Each project, whether public works or work-relief, is to be approved on its merits regardless of its cost per man-year; it is expected that, for the country as a whole, the low figures of many work-relief jobs will balance the higher figures of some public works projects. For the individual highway project under the Bureau of Public Roads, the $1400 requirement is out; but it is expected that each state will be able to absorb a share of the relief rolls on an average of $1400 for the whole state. Those well informed on the highway picture believe that the availability of much low-cost work and of funds from other than relief sources will make it possible under the new set-up to carry on a normal program by normal methods.

ALL this represents real progress. Yet, if the potential gains are to be realized, the industry still faces a job. It still must do what it can to have the largest possible share of the funds so expended as to make for normal employment and genuine recovery. This is a selling job and much of the effort must be exerted locally, guided and coordinated through national organizations.

For example: most non-federal works must go through PWA on a basis of a 45% grant. Thus, on such projects a community will have a chance to get a useful and needed improvement, built by a responsible contractor under a competitive contract, employing competent workmen at normal wages. But it must find 55% of the cost through a PWA loan or otherwise. Will it see the advantages of doing this? Or will it choose to fall back on "made-work" of doubtful value and lose the opportunity to enlist federal help in making a worth while community investment? In every community there will be an opportunity for the organized construction industry to put this matter clearly before the people and their officials.

Then, too, the industry as a whole has the job of strengthening this trend toward more rational procedure. It should seek in drawing labor from relief rolls, the greatest possible freedom to select competent and worthy men: it still must work for further revision of the regulations to make them more practical, more equitable and more effective as an influence for genuine recovery.

The revisions now announced indicate progress. They make possible a rational public works program; they show that consistent and unified effort can correct mistaken trends. But they show also that to make that program a reality the construction industry must stay right on the job.

Willard Chevalier

ENGINEERING NEWS-RECORD

Published every Thursday. Vol. 115, No. 2. Price 25c. per copy. Subscription, domestic, Mexico, Central and South American countries, $5 per year. Canada, including duty, $7.50. All other countries $9 a year or 36 shillings. Entered as second-class matter April 11, 1917, at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A. Cable Address "McGrawhill, New York." Member A.B.P. Member A.B.C. Copyright 1935 by

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Editorial and Publishing Offices: 330 West 42d Street, New York; 520 North Michigan Avenue, Chicago; 883 Mission Street, San Francisco; Aldwych House, London, W. C. 2, England. Branch Offices: Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C.

JAMES H. McGRAW, Chairman of the Board
MALCOLM MUIR, President
JAMES H. McGRAW, JR., Exec. Vice-Pres.
WILLARD CHEVALIER, Vice-President
B. R. PUTNAM, Treasurer
D. C. McGRAW, Secretary

Printed by The Schweinler Press, N. Y.

YOU ARE PAYING

- Positive Traction on both crawler belts while turning as well as when going straight ahead.
- Self-cleaning crawlers.
- Slow speed heavy duty gasoline, oil or Diesel power.
- Helical Gear Drive running in oil and mounted on ball and roller bearings.
- Ball and roller bearings on all high speed shafts.
- Smooth acting, cool running—long life, swing clutches.
- "Feather Touch" clutch control.
- Cushion clutch provides gas machine operation with the cushion of steam.
- Controls and pedals arranged for maximum speed without fatigue on continuous operation.
- Welded Shovel Boom
- Welded Dipper sticks

  Proved through years of service.
- Positive Independent Crowd utilizes forces that other shovels waste.
- Oil reservoir in sheaves. Better lubrication with less attention.
- Simplicity of design and construction. Accessibility of all parts.
- A record of high output equalled by no other machine on the market.

NORTHWEST ENGINEERING COMPANY

The world's largest exclusive builders of gasoline, oil, diesel or electric powered shovels, cranes, draglines, pullshovels and skimmers

1727 Steger Building, 28 E. Jackson Boulevard, Chicago, Ill., U. S. A.

ENGINEERING NEWS-RECORD

Editorial Staff
V. T. Boughton
W. G. Bowman
Chicago
W. W. De Berard

McGraw-Hill Publishing Co., Inc. Editorial and Publishing Offices: 330 West 42d St., New York

F. E. SCHMITT, *Editor* WILLARD CHEVALIER, *Vice-President*

Editorial Staff
C. S. Hill
H. W. Richardson
San Francisco
N. A. Bowers

CONTENTS FOR JULY 11, 1935

VOLUME 115 NUMBER 2 COPYRIGHT 1935

Foundation Work on New York Post Office.. 37
Iron-Plate Arch Used in Indiana Bridge..... 41
Prefabricated Houses Command New Attention 42
S.P.E.E. Soils Study Conference..... 45
Soil-Bearing Tests on Proportional Areas.... 46
BY MARVIN L. DAVIS
Owens Valley Aqueduct Extension..... 47
Concrete Lining of Chicago Ave. Tunnel..... 49
BY FRANK RASMUSSEN
Electricity Measures Concrete-Sand Moisture 52
BY CHAS. E. WUERPEL
Final Report of the A.S.T.M. Meeting..... 55
Los Angeles Meeting of the A.S.C.E..... 59
Letters to the Editor..... 61
Editorials 62
Current News 64
Unit Prices 70

In The News:

MOST SIGNIFICANT NEWS OF THE WEEK was the President's statement defining the types of non-federal projects that will be allotted to PWA under Mr. Ickes and to WPA under Mr. Hopkins. Any project over $25,000 is a PWA project, and applications are to be filed with state PWA engineers as formerly. Projects rejected by PWA go immediately to WPA for consideration.

THE WAGNER LABOR RELATIONS BILL, providing for self-organization of employees and the setting up of a National Labor Relations Board as overseer of such organization, was signed by the President last Friday. It is expected to follow the NRA precedent in receiving a ruling on its constitutionality.

AGAINST A BACKDROP OF POLITICS, Maine saw its Passamaquoddy tidal power project start last week, while Georgia faced a loss of its share of federal highway funds.

THE CONSTRUCTION LEAGUE, in a meeting in New York on Wednesday, launched a campaign to promote "useful employment under the Works Relief Act," by encouraging non-federal public works, utilizing normal methods and aided by federal grants, which increase in proportion to the speed with which the jobs are completed. It was also proposed to substitute for the direct-labor restriction of $1,100 per man, a plan that would take factory and transportation labor into account.

LOWER RENTS for future large-scale PWA housing projects are made possible by the ruling last week that authorizes a 45- instead of a 30-per cent grant, and a 60- instead of a 45-year amortization period.

CONTRACTS HAVE BEEN ORDERED for all future Province of Ontario roads on the basis that the recent relief-labor system has proved too costly and wasteful.

In This Issue:

A REMARKABLE INNOVATION in circular-caisson sinking is proving successful in the construction of the 112 foundations for the new Federal Building and Post Office in New York City. By preparing the lower end of the steel caissons with sawteeth and setting them under a rotating head, the caissons drill their way to rock through clay, hardpan and boulders at a speed of 12 to 20 ft. per hour. Where necessary, an airlock is installed, to bottom-out the caissons.

THE PROGRAM of the summer meeting of the Am. Soc. C.E., held in Los Angeles last week, covered important West Coast engineering problems. The first half of the report is published in this issue.

PREFABRICATED HOUSES are again in the news, by virtue of the promotional efforts of several newcomers to the field. One contrast with former attempts is the inclusion of prefabricated mechanical facilities; another is the tendency to sell a house and not just a particular material, although the tendency is, in fact, not very pronounced.

VARIABLE MOISTURE in the sand proved a troublesome factor in maintaining a proper water-cement ratio for the concrete going into the Alton locks on the Mississippi River. The army engineers devised a method of measuring this variation by installing electrodes in the batcher and measuring the electrical conductance of the sand, which varies directly with the moisture content, requiring only correction for temperature. The method proved sufficiently accurate to be practical, and the speed with which it could be followed was particularly advantageous.

IN DETERMINING soil-bearing values for foundations of an industrial power house in Akron, Ohio, use was made of load tests on small areas proportional to the areas of the footings. Data from the time-load settlement curve and the load-settlement curve were used in predicting a maximum probable settlement of $\frac{3}{8}$ in. under a 6,000-lb. per sq.ft. load. A year later an average settlement of $\frac{1}{8}$ in. is indicated by check levels.

LOS ANGELES, in addition to going east to the Colorado River for water, is extending its Owen Valley Aqueduct to new sources as far north as the latitude of San Francisco. A particularly important element of this new construction is the 11-mile Mono Craters Tunnel.

BY COMBINING an old-time continuous-paddle concrete mixer with modern belt- and screw-conveyor placing equipment, the Chicago water department has available a particularly useful piece of plant for lining the new Chicago Ave. tunnel.

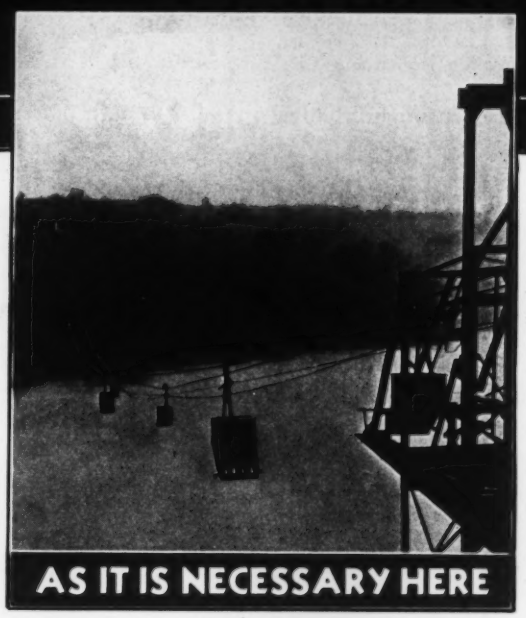
THE CONCLUDING INSTALLMENT of the report of the American Society for Testing Materials convention covers research and specification developments in cement, concrete, brick, asphalt and timber.

Coming Articles:

NEW AND INTERESTING DESIGNS of lighthouse foundations for soft bottoms have been developed in the recent extensive program of construction and renovation financed by the PWA. Chas. A. Park, chief engineer, Bureau of Lighthouses, describes those of greatest engineering significance in an article scheduled for next week's issue.

THE "AERIAL TRAM LINE" *is a "bee line"*

AS ECONOMICAL HERE



AS IT IS NECESSARY HERE

ALWAYS, when chasms or water or hilly ground step in to block off the delivery of materials—the cry goes up for an Aerial Tramway. And rightly so. Because—9 times out of 10—no method other than the "bee line" method of the "tram" could tackle such a job and "whip" it. But—and, this is equally true—there is scarcely a transportation job on any kind of terrain—no matter how easy of access—where the use of an **American Steel & Wire Company Aerial Tramway**—will not increase efficiency and lower costs materially. Steadier operation—never interrupted by bad weather—greater tonnage capacity per hour—lower cost per ton mile. Surely such advantages are worth your looking into. Our engineers will be glad to investigate and report their findings on your transportation problems. Send for our new Aerial Tramway Handbook.

AMERICAN STEEL & WIRE COMPANY

208 S. LA SALLE STREET, CHICAGO • • EMPIRE STATE BUILDING, NEW YORK

Offices in All Principal Cities

Pacific Coast Distributors: Columbia Steel Company, Russ Building, San Francisco

Export Distributors: United States Steel Products Company, New York

United States Steel Corporation Subsidiary

ENGINEERING NEWS-RECORD

July 11, 1935

FIG. 1—STEEL CYLINDERS rotated through the soil to rock form foundation caissons for the New York Federal Building. The rotor tower at the left of this view is picking up a prepared cylinder preparatory to spinning operations. Completed caissons can be seen at the right, and air locks used in sealing some of the caissons are in the background.

Rotating Foundation Caissons Drill Their Way to Rock

Huge steel cylinders rotated by novel rig through sand, clay and boulders while high-pressure jets excavate their interior in constructing the foundations of the new Federal Building in New York

CLAMPED TIGHT to a rotating head riding on a high tower of a rig that resembles a massive skid piledriver, huge steel cylinders with a sawtooth cutting edge are being drilled down to rock through 65 to 70 ft. of sand, clay and boulders, to form the foundation caissons for the new federal office building in lower Manhattan, New York City. By this new method of foundation construction, cylinders from 4 to 8½ ft. in diameter and averaging 66 ft. in length are literally spun through virgin soil, while high-pressure revolving jets excavate most of the contents of the shell during the sinking operation. Sinking progress varies with soil and boulder conditions but usually runs between 12 and 20 ft. per hour. Thus, caissons are being sunk in four to six hours, as compared with the usual six to eight days required under compressed-air methods on similar work in New York. Finishing and sealing are done, in most cases, in one or two additional shifts.

The new post office and office building occupies the site bounded by Church, Barclay, West Broadway and Vesey Sts., roughly 203x380 ft. in size. General lot excavation was carried to El. —4 (mean sea level is El. 0; street level is approximately El. +20). Groundwater was encountered at the basement level. The subsoil consists of a sand formation containing some clay overlying a stratum of sandy clay, giving way to gravel with a thin layer of conglomerate hardpan on top of typical Manhattan schist bedrock. The rock is very uneven in surface, but lies in general at El. —70. Through the lower soil formations are scattered numerous boulders, some of large size.

In the call for bids, caisson foundations were listed as an alternate to steel piles. The low bid favored caissons. The plans require 112 caissons from 4 to 8½ ft. in diameter, all to be carried to rock. Shell thicknesses were specified to vary from ⅜ to ½ in. A few of the caissons will carry loads in excess of 3,500 tons. Some 50 core borings had been taken over the site; the probable rock elevation at the location of each caisson was determined by interpolation.

Fabrication of shells

Each caisson is fabricated for a specific location and shipped from the plant of the Petroleum Iron Works at Sharon, Pa., in two cylindrical sections approximately equal in length. Fabrica-

tion is by shop-welding; two or three longitudinal strips, depending on the size of shell, make up a section. To the bottom of the lower section is welded a working chamber that forms the cutting edge. Internal stiffening rings, welded to the shell, consist of either 8-in. curved channels or 1x8-in. plates. One or two angle irons, the number depending on the size of shell, are welded longitudinally to the inside of the lower-half section, to form triangular revolving jet pipes; when only a single one is used, it is carried down to within 15 in. of the cutting edge; when two are required, the second one is left somewhat higher, to avoid damage during rotation in rock. The lower end of each such jet pipe is protected by a reamer block welded to the shell.

The top half of the caisson cylinder is similar to the lower half, except that 2-in. pipes instead of angles are fastened to the inside and connected to the lower section. To the top of the upper section is riveted an inside flange angle for attachment to the rotor headplate.

The caisson shells are trucked from a railroad siding to the job on trailers, usually with a section of smaller caissons nested inside the larger ones. They are unloaded by cranes at the job, and the two halves of each shell are set up on skids for further fabrication. A hydraulic jacking rig forces the two cylinders together and holds them while they are arc-welded by a butt ring joint, to form the full-length caisson.

While the shell is still on the skids, cutting teeth are formed in the lower end with a gas torch. Several designs of cutting edge have been tried, the type shown in Fig. 4 being preferred. As the teeth are cut, they are heated by the cutting torch, and alternate teeth are bent inward and outward to give a set as in a saw; the amount of set is such as to produce a kerf twice the thickness of the cutting-edge plate.

To prevent wear of the cutting teeth, their exposed faces are coated with a thin layer of tungsten carbide. This material is applied by gas-welding, using a Haystellite composite welding rod containing particles of tungsten carbide in a binder of high-test steel. In cases where it was possible to examine the cutting teeth after the caisson was down, no evidence of excessive wear was apparent.

Experiments have been made with other types of cutting teeth. On one or two caissons alternate sectors, each one-eighth circumference, were cut out as teeth, leaving the other sectors blank as riding edges. With this type of cutter chilled shot was introduced through the jet pipes as a cutting medium, and no hard surfacing was applied to the teeth.

The final preparation of a cylinder consists of bolting on the rotor headplate. Various sizes of headplate to fit shells of different diameters are kept on hand. These headplates contain tapped connections for hose supplying the jet pipes in the shell. Also in the headplates are a jet connection to the cylinder chamber and a controllable-pressure relief outlet pipe.

Rotating rig

The rig for sinking the caisson resembles a huge skid piledriver. An all-welded structural-steel tower 78 ft. high is carried on a welded bed frame, braced by collapsible outriggers. On the back end of the bed frame is mounted a three-drum electric hoist, one line reeved through the head sheave in sixteen parts to handle the rotating head, the two other lines going to a short-boom derrick mounted high on the tower which hoists the cylinders into place (Figs. 2 and 3). The rig is skidded around by lines to the hoist niggerheads. The entire rig weighs 51 tons.

Riding in leads on the front face of the tower is the rotating head assembly, weighing 11 tons (Fig. 5). The assem-

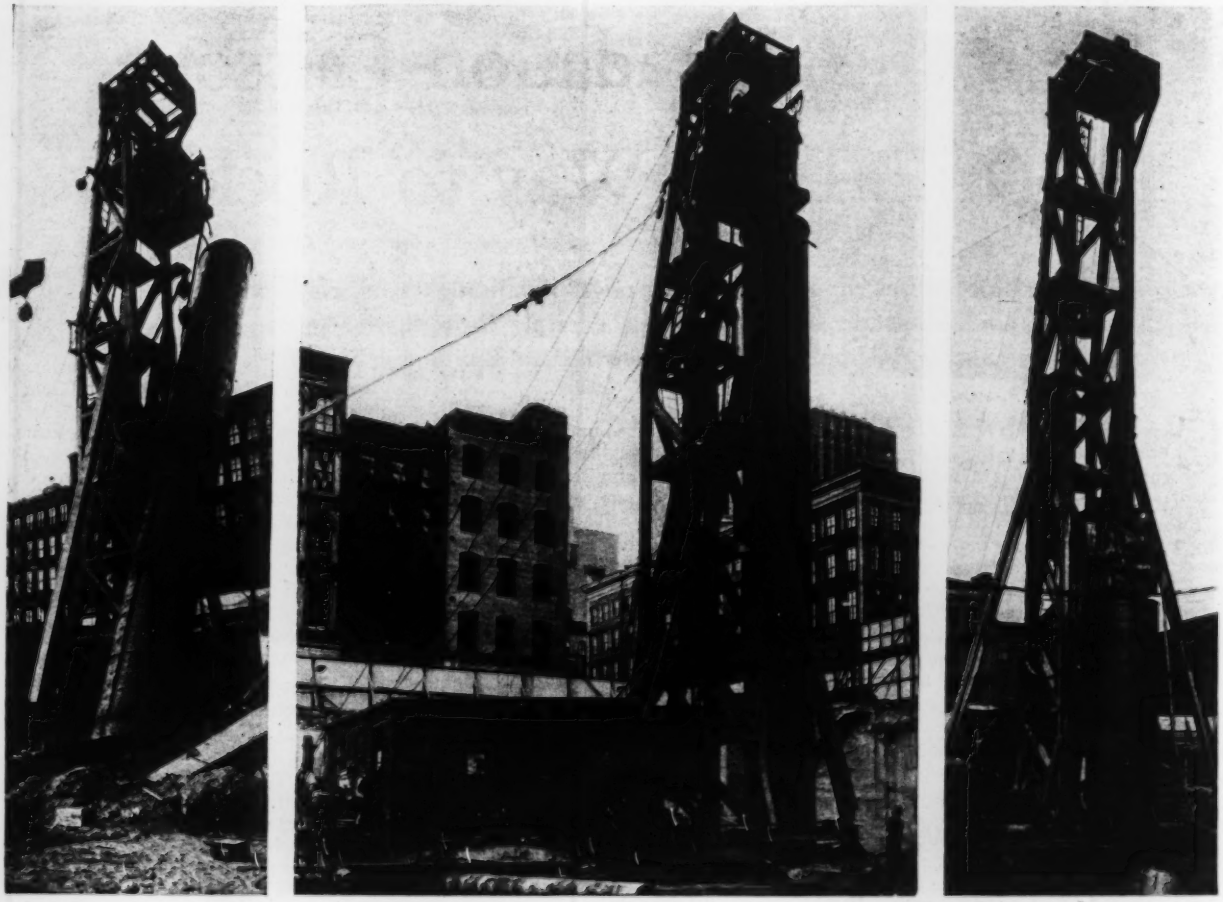


FIG. 2—TOWER RIG ON SKIDS lifts the caissons to place, centers them over the desired spot and provides the necessary power for rotating the cylinders downward to rock.

bly consists of a 125-hp. electric motor that drives the rotor head through a worm-gear reducer, gearing the motor down 220 to 1. By this reduction a torque of 1,000,000 ft.-lb. is available for rotating the cylinders. Connected to the driving shaft is the rotor head, equipped with driving lugs to engage lugs welded on the cylinder headplate. The two sets of lugs are held together by steel keys, permitting reversal of the normal rotation.

The rotor-head assembly is fitted with two thrust bearings, one capable of lifting the entire load of rotor assembly and shell—a maximum of 35 tons, comprising 11 tons for the rotor and 24 tons for a shell of the largest size. To permit lifting a shell out of the ground, if this should ever be desired, the head tower, hoist line and thrust bearing were made capable of taking a 70-ton load. The other thrust bearing is for loading the rotor assembly, to force the cylinder down if necessary. So far this loading has never been required, as the weight of the caisson cylinders gave sufficient feed pressure in every instance. Through the center of the driving assembly is carried the water line for the jet.

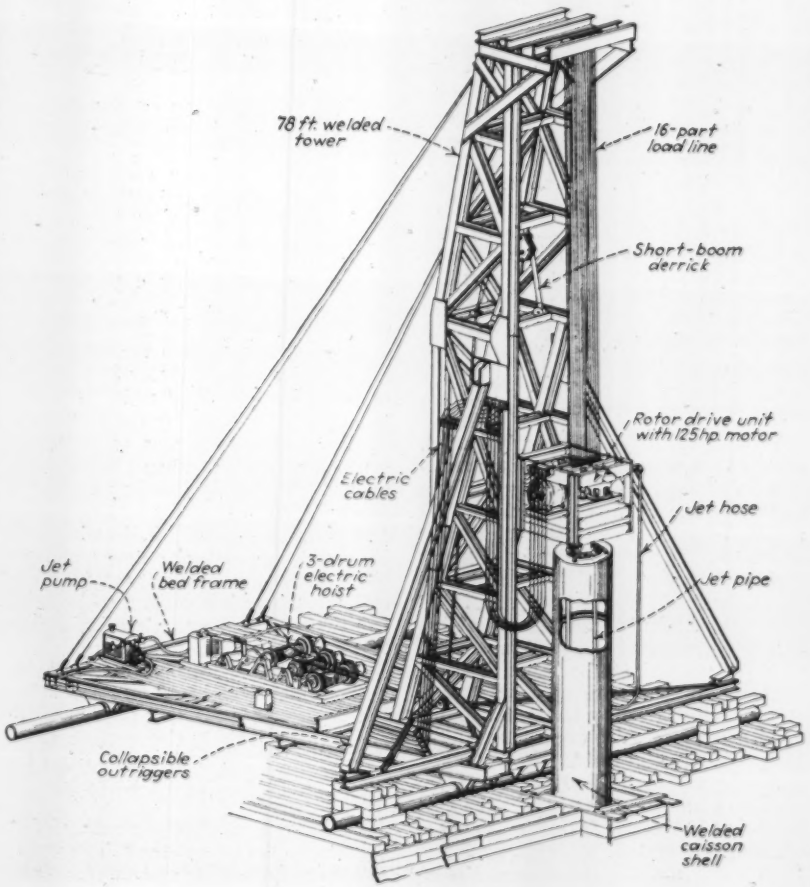
To set up and start a cylinder, a shallow square sheeted pit is dug and a guide frame of timbers is built around the top. The cylinder is picked up by the tower derrick, assisted by a crawler crane at the start in maneuvering the ungainly shell into an upright position. A sliding platform at the base of the tower, handled by a niggerhead line, keeps the shell from banging into the tower as it is being raised. Other niggerhead lines assist in pulling the cylinder into place.

Once the shell is upright in front of the leads, the rotor head is lowered and coupled to the cylinder headplate, the jet lines are connected, and the caisson is ready for sinking.

Rotating operations

As the cylinder is set on the ground, its weight forces the shell down a short distance, creating a seal. Before rotation starts, the jet pump is started to fill the shell partly full of water. Then power is turned on the rotating motor, and the cylinder starts its downward spin. Spinning and lowering are both controlled by the hoist operator. An ammeter in front of the operator's position tells him what current the rotating motor is drawing; from 100 to 200 amp. is required most of the time, but in hard going the current rises as high as 400 amp. The latter amount is the limit allowed by a circuit breaker in the line.

FIG. 3—WELDED TOWER AND BEDFRAME carry a three-drum hoist and rotor assembly for handling and spinning the caissons.



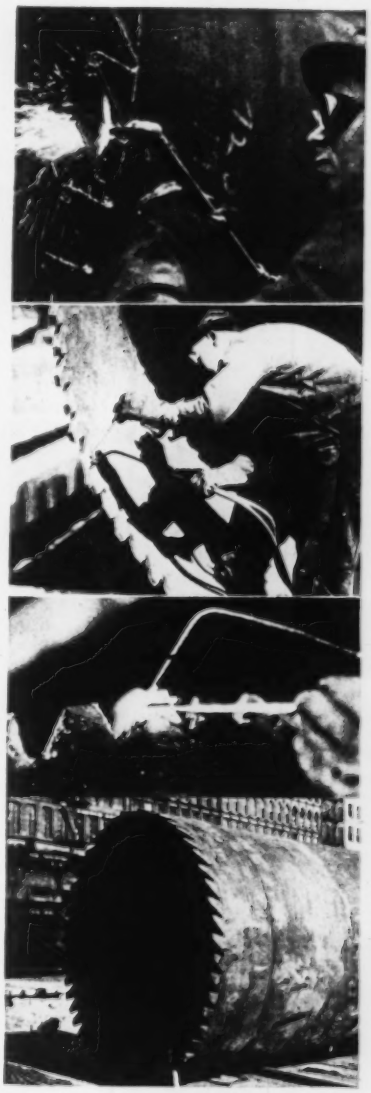


FIG. 4—CUTTING TEETH are formed by burning out a saw-tooth edge on the lower end of the cylinders, giving the teeth a set, and welding on a wear-resisting face of tungsten carbid. Bottom view D shows a cutting edge ready for spinning.

It is the operator's business to control the drilling load within this limit. He holds the hoist line carrying the entire rotor head and shell load by a brake, and thus controls the feed pressure and hence the drilling power. If the cutting edge strikes a boulder or other hard-cutting condition, the shell can be held without lowering, can be raised or can be lowered as slowly as desired. As long as the ammeter indicates easy going, the shell is allowed to sink of its own weight. The speed of rotation can be varied from 3½ to 11½ r.p.m. at the will of the operator, or the direction can be reversed.

Rotation of the shells is slightly eccentric, as the lug connection on the cylinder headplate is such as to set the cylinder slightly off center.

The jets build up a hydrostatic head within the cylinder, which forces the water out underneath the cutting edge.

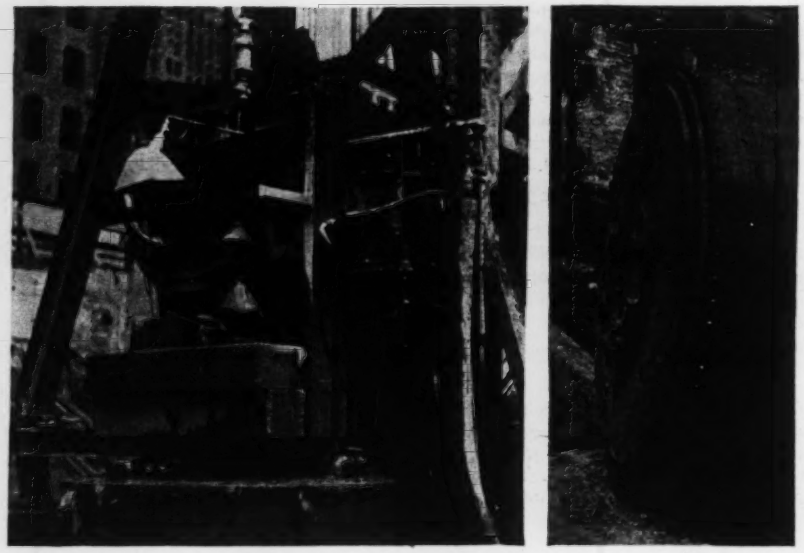


FIG. 5—BUSINESS END of the caisson machine is the rotor assembly, which rides down the tower leads as the caisson bores its way to rock. A view of a cylinder headplate with lugs to which the rotor is attached is shown at right.

This water travels up the outside of the shell with a spiral motion in relation to the surrounding soil, and vertical in relation to the spinning cylinder. The action of the cutting edges and the jets stirs up and washes the soil, and much of the interior contents of the shell is carried out with the jet water.

As the waste jet water, carrying the excavated soil with it, boils up into the sheeted pit, it is led off through a series of trenches. Here most of the soil drops out, and laborers in the trenches shovel it out as fast as it is deposited. The muddy water carrying fine suspended matter goes to the sump pit of the jet pump. The contractor reports muddy water used for jetting lubricates the cutting edge, lowers skin friction and in general gives more satisfactory results than does clear jetting water. Recirculation of muddy water is naturally hard on the bearings of the centrifugal jet pump. By coating the bearings with tungsten carbide and grinding to fit, the contractor increased the life of the pump bearings from 4 to 40 caissons before repairs were required.

The possibility of loss of ground by this method of sinking caissons has proved remote, in the contractor's judgment. The jets maintain a hydrostatic head within the caisson sufficient to prevent inrush of earth from below. The eccentric wiping action of the rotating cylinder on the surrounding soil tends to seal and plaster the cut surface, preventing the soil from washing upward with the waste jet water; even in sand there was no evidence of washing or running of the material surrounding the caisson.

Boulders have caused but little trouble. When firmly embedded on the caisson line, they are cut through by the revolving shell. If they lie mostly within the caisson, they are usually pulled loose and remain inside. Fig. 6 shows a boulder neatly cut in half by the cutting edge.

Every effort is made to get the cutting edge well into rock before rotation is stopped. Because of the undulating surface of the ledge, it is impossible to tell exactly the elevation to which the caisson should be carried. The operator, after all, can judge only from the action of the spinning shell as to its probable depth of seal into the rock. In some cases he was misled by a pocket of unusually tough hardpan and large boulders overlying the rock; in other cases, part of the shell had cut well into a rocky promontory, while the other part remained clear of the ledge, and he falsely concluded from the behavior of the caisson and the power drawn that the entire circumference was in rock.

Air sometimes required

When a caisson is apparently landed, the rig is moved off and the rotor headplate is removed. It is found that from 65 to 75 per cent of the material within the shell has been excavated by the jet water, but that a mass of boulders, lumps of hardpan, stones and other materials not pulverized by the jets remain in the caisson. The bulk of this material is removed by a small clamshell or orange-peel bucket, and at the same time the water is pumped down by a small electric centrifugal pump lowered into the shell, but the crucial excavation at the bottom is done by hand. The bottom is carefully approached, to determine the position of the cutting edge with respect to rock. If there is indication that the shell is not sealed into rock and that further excavation and pumping will invite a run-in, operations are stopped until the caisson can be rigged for air.

It has been necessary to put air on about half of the shells for final sealing. For this work, an adapter plate is bolted to the top flange of the shell, to receive a standard caisson lock. Under air the caisson is cleaned out, and I-beam posts are used as underpinning under parts of the shell that do not bear directly on rock. Boulders are broken up by plugs and feathers for passage through the air locks. In most every instance the air work has been cleaned up in one or two shifts.

Only in four cases was the shell found to be hung up high enough above rock to require further sinking. This was done by loading the cylinder as the support under the cutting edge was cut away.

FIG. 6—BOULDERS are cut through or displaced by the rotating cylinder. Here is a bluestone boulder cut in half by a spinning caisson, backed up by J. A. Montee, who is largely responsible for the development of the machine and the caisson-sinking method.

Specifications require that a drill hole shall be sunk 5 ft. into the bottom for inspection purposes. Under 35 lb. of air in the caisson the drill action was materially slowed down by the back pressure. This difficulty was overcome by connecting the drill exhaust line into the caisson blow-off pipe, leading directly to atmosphere.

A seal of concrete 25 ft. deep is placed when the caissons are under air. In those caissons that did not require air to seal, the bottom was cleaned off by hand, and seal concrete was placed with bottom-dump buckets for a depth of 10 ft.

Reinforcing dowels are set into the concrete as the fill nears grade. After the concrete has set, that portion of the shell which projects above grade is cut away with a torch. Some of these top portions are utilized as sump pits for the jet pumps.

Building a grid of concrete girders connecting the tops of the caissons completes the foundation system. An elabo-

rate system of well points has been installed to lower the groundwater, to permit the excavation of the girder trenches in the dry. The foundation contractor will place the basement floor mat and will build the exterior basement wall to street level.

Development of caisson machine

The method and caisson-drilling machine used on this job were developed by J. A. Montee working with the George J. Atwell Foundation Co., subcontractor for the foundations of the Federal Building. Apart from experiments conducted in Long Island City with 24-in. shells, the process was wholly untried when this job was begun. The first caisson was sunk last January, under most unfavorable weather conditions. Early difficulties were discouraging, and more than once the process seemed doomed to failure. However, minor changes and experience with the process eventually ironed out the difficulties. By April, operations were going smoothly and according to schedule, with delays reduced to a minimum.

Some of the more important changes made as the process developed include welding the two sections of caissons together instead of bolting, as first used, and changing the jet-pipe connections through the headplate from the early locations in the side of the shell near the top.

Direction

Construction of the new building is under the supervision of the public works branch of the procurement division of the Treasury Department. W. E. Reynolds is assistant director of the procurement division in charge of the public works branch, and Neal A. Melick is supervising engineer. In direct charge at the site is William H. Kelley, construction engineer for the government. James Stewart & Co., Inc., New York, is general contractor, with John Finegan as superintendent in charge. For the George J. Atwell Foundation Co., A. G. Sperl is general superintendent, J. A. Montee is supervising the caisson work, and George Salle is in charge of air work.

Iron-Plate Arch Reduces Load of Marshland Bridge

Metal-arch ring and spandrel walls meet light foundation load requirements of an Indiana road bridge

IN BUILDING a short section of road across marshland near Syracuse, Ind., a light metal arch was adopted to reduce foundation expense. As shown, the bridge carries the road over a boat channel across the marsh. Its interesting feature is that the spandrel walls as well as the arch ring are metal, the latter being a multi-plate corrugated iron arch.

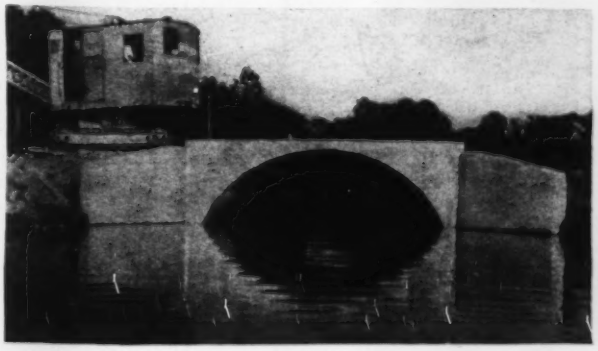
An arch with a span of 22½ ft., a rise of 9 ft. 2 in. and a width of 25 ft. was chosen to provide the necessary opening. To secure the proper foundation for the footings and wing walls, 12-in. piles were driven: 27 piles on 3-ft. centers in each footing, 5 piles under each wing and 17 piles under the abutment proper. The piles averaged a little over 14 ft. in length, after they were in place.

Concrete footings and wing walls were built on the piling placed as described. A cofferdam of interlocking sheet-steel piling was used during driving, building forms and pouring the footings and wings. As a seat for the arch, a standard 3-in. steel channel was set in the footing with a face sloped so that the arch would enter it at a right angle. When the footings and wings for one side of the arch were completed, the sheetpiling was pulled and utilized in building the foundation and wings for the other side.

Pulling the sheetpiling left the arch seat about 4 ft. under water. To assemble the plates forming the arch under such conditions, the following plan was used: one half of the arch was assembled in the roadway and lowered into its place on the footings by a 1½-yd. dragline, which was on the job to pull the sheetpiling. This half of the arch was held in place at about the correct elevation by three tackle blocks, the two at the ends being fastened to the wings and the one in the center to a dead-man placed in the roadway. When the other half of the arch was assembled, it was lowered into its place in the channel on the other footing. Then, by adjusting the height of the section last placed with the dragline and the first section by means of the blocks, the two halves were joined and all bolts placed and tightened, those underneath by laborers working from a raft built of oil drums.

The metal spandrel walls, which were chosen because they were lighter and could be placed directly in the water, were assembled on the bank and lowered into place behind the wing walls and in the valley of the first corrugation at each end of the arch. They were then fastened securely to the arch by hook bolts and braces, which passed through the heavy angle at the top of the wall and were bolted to the horizontal seams of the arch. Turnbuckles were provided in these braces, to make any adjustments necessary in keeping the spandrel walls perpendicular.

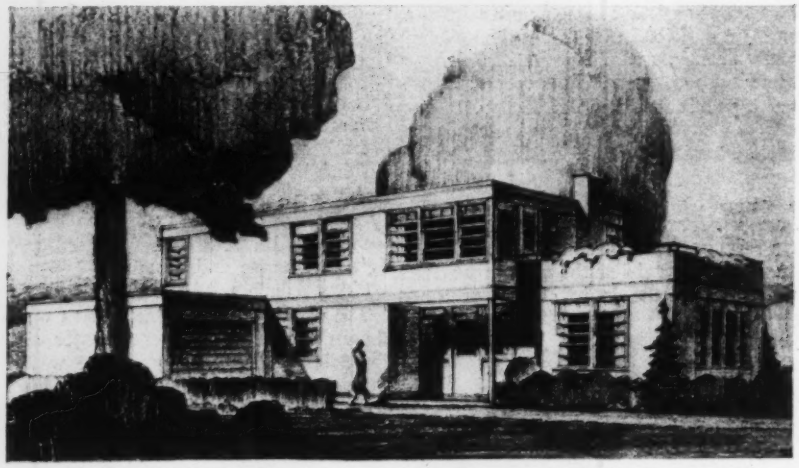
The assembly of the arch, including the spandrel walls, was completed in three eight-hour working days by a crew of four men, a crane operator and a foreman. The crane was used only for lifting and therefore was in actual use only a small fraction of the time required for erecting the structure. Backfill was made by the dragline, utilizing marl and gravel dug from the channel adjoining the road. In placing the fill, care was taken to keep both sides at about the same level, to avoid unequal loading. The installation was made under the direction of Robert J. Pfleiderer, county engineer, Kosciusko County, Indiana.



CORRUGATED-IRON ARCH (left) with metal spandrel walls; and (right) arch ring of 25½-ft. span as assembled ready for the wing walls and backfill.

Prefabricated Houses Bid for New Attention

This time emphasis is being placed on mechanical accessories as well as on factory-produced frames, walls and floors—Plywood brings timber into the picture



FRAMELESS STEEL HOUSE being erected near Chicago, as sketched by the architect.

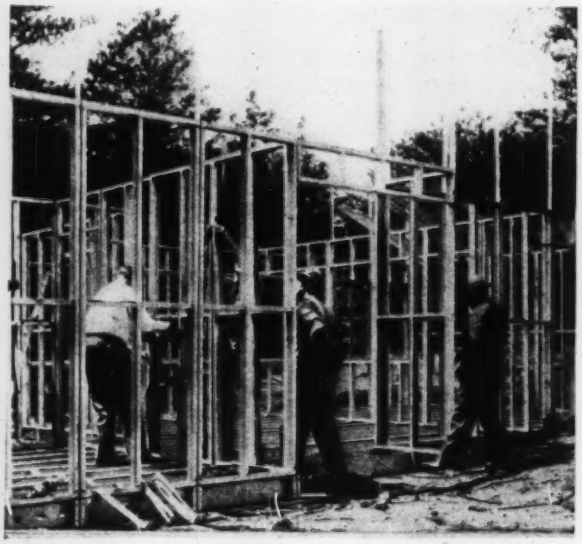
THE IDEA that the need for less costly and better houses can be supplied by prefabrication has been advanced time and again during the past decade. Thousands of dollars have been spent on research, and many meritorious plans have been advanced. While none of them has aroused the necessary public buying demand, the belief still persists that the idea is sound. Now, after a three- or four-year period of quietness, prefabricated houses are again witnessing rising activity. At least three new commercial enterprises are under way, each with strong financial backing, and in addition a campaign is beginning, to interest woodworking concerns in the manufacture of prefabricated timber dwellings.

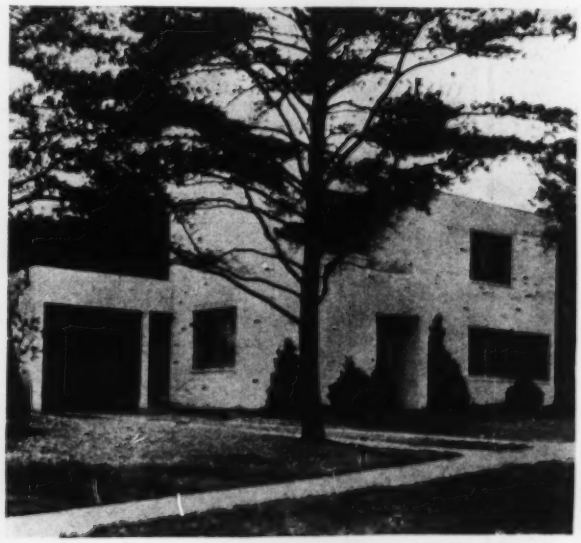
In Chicago, General Houses, Inc., announced recently that it had been granted the first government insurance on a mortgage loan for the construction of a house of steel. The structure, a two-story steel-panel residence, is scheduled for completion by August 15. It is located at River Forest, a Chicago suburb, and the amount of the mortgage loan is $12,500. This company, which has been in the field for several years, has built five "frameless" steel houses in the Chicago area and others elsewhere. An architect's sketch of the River Forest house, which is being built for sale by an operative builder, comprises one of the accompanying illustrations.

Unit steel frames

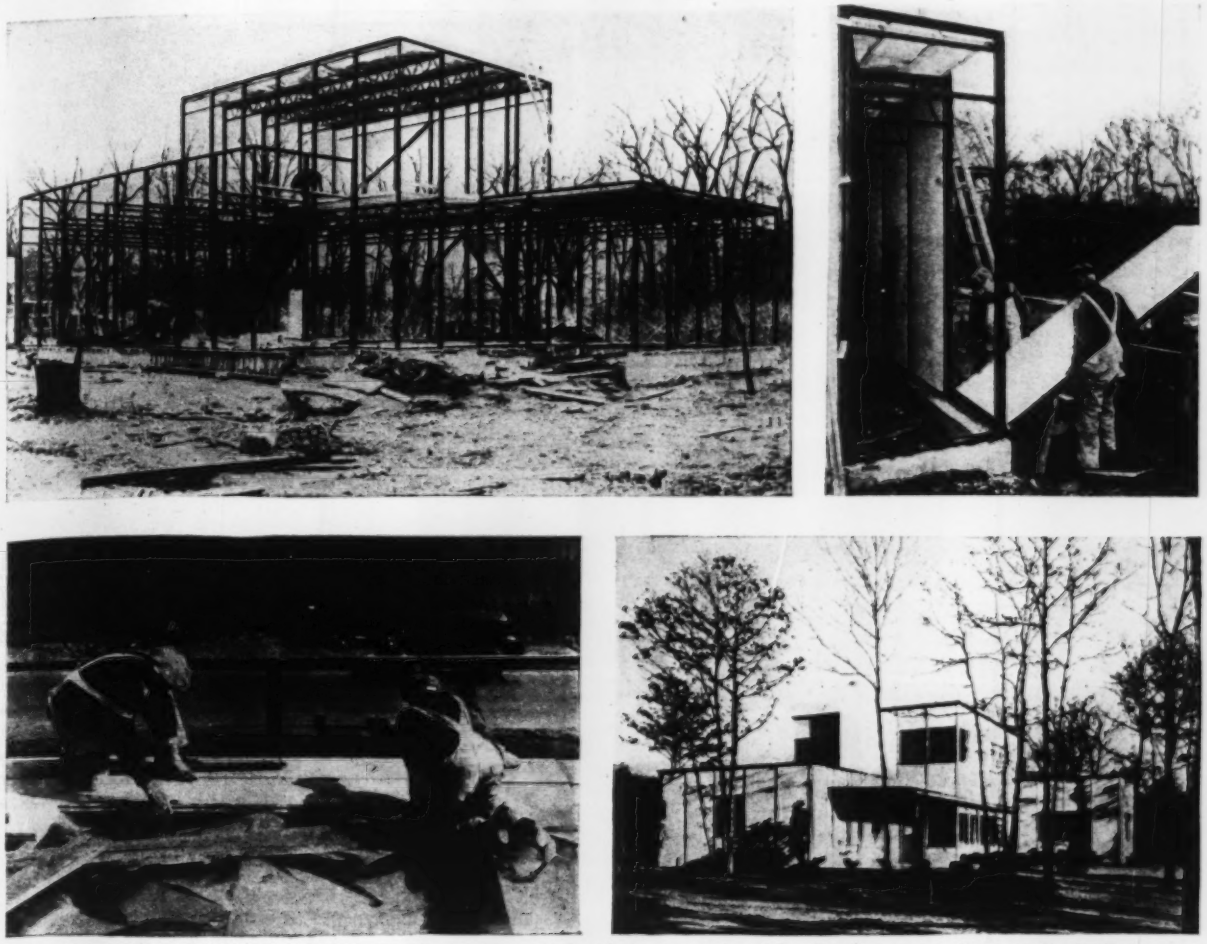
In Bethesda, a suburb of Washington, early in May the entire steel frame of a Berloy seven-room house and garage was completed by five men in fifteen hours. Construction of a second house has followed completion of the first. Based upon the use of wall and floor frames shop-fabricated from strip steel, these new houses, developed by the Berger Manufacturing Co., a Republic Steel Corp. subsidiary, from designs by Kastner & Stonorov, Philadelphia architects, may be enclosed in any standard building materials; brick is being used for the first two houses. Each of the new houses contains about 4 tons of steel. An important feature is a complete plumbing stack together with heating and air-circulating ducts, all prefabricated and bolted in place within the frame. The houses are priced at $6,950, including lot, landscaping, sidewalk and drive.

The prefabricated frame units of the Berloy house are rectangular, 3 ft. wide and of desired ceiling height; they are of a weight that can easily be handled by one man. Individual members are of channel shape. Frames for blank wall surfaces are interchangeable with frames containing doors or windows. The frames are bolted to a steel member embedded in the foundation and





ASSEMBLING the pressed-steel frame (left) of a new brick-enclosed prefabricated house near Washington, D. C., whose completed appearance is illustrated at the right. In the left view, note the splice strips for second-story framing.



BUILDING A PREFABRICATED HOUSE which is sold complete ready for occupancy and in which every part is factory-produced. Top, left: Steel frame up and floor slabs being installed. Top right: Erecting cement-asbestos wall units. Bottom left: Laying roof slabs over aluminum foil insulation. Bottom right: Completed house.

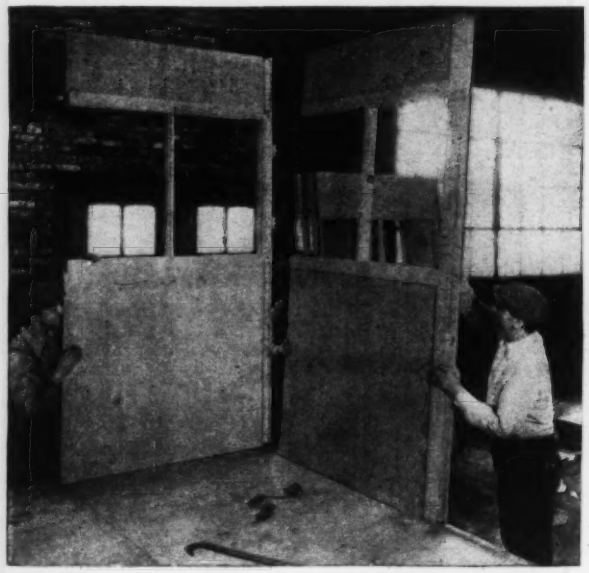
then are bolted to each other. Second-story frames are spliced to the first-story frames by steel strips placed between the channels of adjacent frames. At the corners, L-shaped strips comprise the connection between the abutting frames. The floor and roof members are also of channel shape. Where possible, the webs are perforated with large holes, to reduce the weight. All metal is 16 gage.

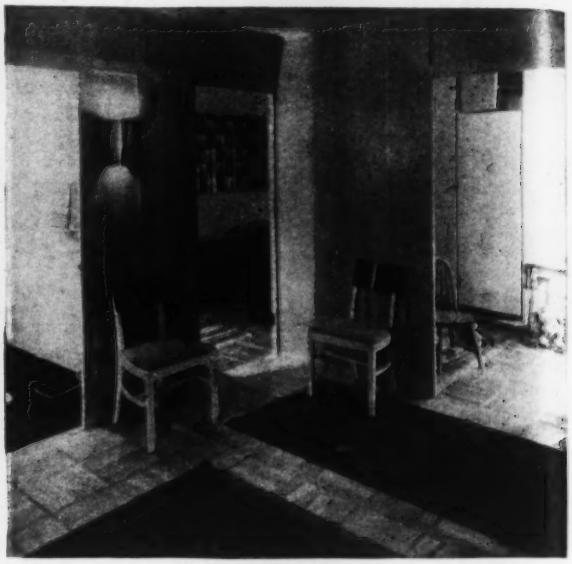
Although the Berger company is only interested directly in the prefabrication of the frame and the plumbing stack, these two new houses, developed by its architects, incorporate other prefabricated parts. The subfloor and subroof consist of 1½-in. slabs of a material made of a mixture of cork and concrete. Metal inserts serve to splice adjacent slabs together and act as well as an anchorage for clips which attach the slabs to the frame. The finished floor is of wood. The roof is completed by a layer of 1½-in. cork slabs covered with asphalt roofing. The exterior walls are sheathed in 1-in.-thick slabs of cork attached to the frame by wires passing around small metal plates extending across the joints between the cork slabs. Interior wall surfaces and partitions are of ⅜-in. gypsum board fastened to the frame with resilient clips. Steel rod anchors tie the exterior brick surfacing to the frame. Air ducts for the heating and air-circulating system are built into the steel frames. Fresh air enters rooms through grills in the ceilings and is vented through grills at floor level. Return air passes through the open spaces in the floors and walls. The Berloy houses have been approved for insurance by the Federal Housing Administration.

Houses offered complete

In White Plains, N. Y., American Houses, Inc., New York City, has built one of its so-called "Motohomes," which closely approach the goal of complete prefabrication. A feature is that the house is sold complete by the sponsoring company, the prefabricated parts being delivered in trucks to the sites where they are assembled by local laborers under the direction of one of the company's superintendents. It is claimed that, from the time the foundations are laid, about two weeks is required to erect the smaller houses and three weeks for the larger ones. The houses vary in size from those having two bedrooms, living room, kitchen, bath and garage on one story, to two-story houses having living room, dining room, maid's room and bath, kitchen and utility room on the first floor, three bedrooms, two baths and storage room on the second floor. One of the larger houses is shown in the accompanying illustration.

The "Motohome" utilizes a steel frame consisting of structural T-studs and 16-in. bar-joist trusses for floors and roof. The exterior walls, of a cement and asbestos mixture compressed under hydraulic pressure and confined in a metal frame that fits beside the stem of the T-studs, come in panels about 3 ft. wide and of ceiling height. Exterior trim over the panel joints is aluminum alloy. The roof material consists of 2-in. slabs of gypsum fitted together with tongue-and-groove joints and placed over sheets of aluminum-foil insulation. The flooring is of the same material as the roof and also 2 in. thick. The finished floors are of hardwood, the fibers of which have been exploded under pressure and then compressed into sheets. Partition wall units are made of a special mineral compound and are held in place by steel channel posts.





TIMBER prefabrication experiment centers in the use of panels of plywood glued top and bottom to floor joists and inside and outside of wall studs. Left: Assembling wall units on the completed floor. Right: Interior of completed house.

Steel casement windows are used throughout.

The houses get their name from the mechanical unit which contains all the plumbing, heating, air-conditioning, electrical and mechanical devices for the entire house. On one side of this unit, which is a metal cabinet the size of a small room, is the kitchen, and on the other side the bath. In the two-story houses this mechanical core extends up through the first-floor ceiling, to provide either one or two baths on the second floor. The unit comes in four sections: a kitchen section, a heating and air-conditioning section, a bathroom section, and, in all but the smaller models, a laundry section. The kitchen section is arranged compactly in a continuous straight line and includes an electric refrigerator, sink, laundry tub and stove, all contained in an enamelled insulated steel cabinet. The bathroom unit is also an enamelled steel-insulated cabinet to which the tub, washbasin and toilet are attached.

Factory-produced timber houses

In Madison, Wis., at the U. S. Forest Products Laboratory, a full-scale model house has been built, to demonstrate the adaptability, to prefabricated dwellings, of a structural system consisting of plywood sheets glued to either side of studs or joists. The structural efficiency of plywood panels of this type has been shown by an elaborate series of tests carried out at the laboratory during the past two or three years. One result of these tests was to show that for a panel having a span of 13½ ft., a joist 5⅜ in. deep is the practical equivalent of a 10-in. joist used in the conventional manner. Thus, plywood panels, designed on this "stressed covering" principle, offer a reduction in both cost of material and in bulk of the floor system.

In the model house recently built, actual design of wall, floor and roof panels was a matter of calculation based on data from the tests and utilizing a module of 4 ft., because this was the width of commercially available plywood. The model house was planned with no spans in excess of 13½ ft., and the depth of floor members was kept down to 5⅜-in., with top coverings of ⅝-in. plywood and lower coverings of ⅜-in. plywood. Contiguous edges of adjacent floor and roof panels were splined, to distribute concentrated loads.

Each of the standard wall panels consists of two sheets of ¼-in. plywood, each 4 ft. wide and 8 ft. long, glued to a central framework of light structural members. The thickness of wall-panel framing was arbitrarily set at 1⅜ in. because it corresponded with the thickness of cheap stock doors. The wall panels are joined by a vertical mullion member grooved on its two edges, to receive the plywood facings which project ¾ in. beyond the internal framework. Filling these grooves with a mastic before the adjacent wall panels were shoved home gave an excellent seal.

An interesting detail was chosen for the windows in which the sash is hung completely outside the plane of the wall. This overcame a difficult waterproofing problem created by the built-up sill members and the thinness of the walls. The space between the sash and the walls is sealed with a spring bronze weather strip.

Electrical needs are provided by building the necessary wiring and outlets into the panels in the process of manufacture. In assembly, an encircling conduit, placed beneath the water table of the house, connects with the panel network. Wiring in interior panels is handled in the same way and connects with a conduit running below the floor. The utility room is adjoined by both bath and kitchen. Heating is by a hot-air circulator placed in the living room.

The finished flooring of the house is also prefabricated. The small pieces are factory-produced and assembled on 4-ft. squares of plywood. These squares are joined in the floor by means of T-shaped parting strips. The bathroom floor represents a special development, being composed of 4½-in. disks of hardwood sawdust chemically treated and molded under pressure, to form a dense, black, impervious plastic.

Special care was taken to provide a preservative treatment for the plywood and for the glue lines between the plywood and structural framework. The exterior finish consists of an aluminum priming coat followed by a second coat of aluminum and a lead-and-oil undercoat. A lead-and-oil finish coat completes the four-coat process.

It is claimed for this house that every architectural feature has its roots in sound engineering. It was erected in 21 hours by seven men. The Forest Products Laboratory is planning further research along lines that the present development has defined.

One-Third of Detroit Houses Reported in Need of Repairs

Thirty per cent of the houses in Detroit need repairs, according to a survey recently made by the Detroit Better Housing Program Committee. All but 4 of the 878 precincts of the city containing 167,404 homes were canvassed, and the investigators reported necessary repairs would cost $21,000,000.

Soils Mechanics Education Takes Step Ahead

Outstanding papers on progress in soils mechanics knowledge and instruction presented at the annual meeting of the Society for the Promotion of Engineering Education

Special Correspondence

GUIDED by the general heading of "Changing Phases of Civil Engineering and their Relation to Education," the civil engineering division of the Society for the Promotion of Engineering Education at the annual meeting in Atlanta, Ga., June 24-25, sponsored a conference on soil mechanics, with a view toward stressing the educational problems involved.

The conference was opened with a paper by F. L. Plummer (Case School of Applied Science) in which he outlined the historic development of soil mechanics, the principles which have been developed during the early years of this new science, and the types of tests which today are more generally used for determining significant soil properties. W. S. Housel (University of Michigan), in a paper on "Research in Foundation Pressures," presented a historic review of experimental studies of pressure distribution in a mass of soil (Strohschneider, Enger, Koegler and Scheidig, Goldbeck and others); a summary of the theoretical results based on the theory of elasticity obtained by Flamant and Michell for the stress distribution of the two-dimensional problems; and a simplified method for presenting the stress distribution in a loaded mass of soil which was derived by the author, and on which he based a theoretical study of soil resistance. (Professor Housel's theory of the bearing capacity of soils was presented in *Engineering News-Record*, Feb. 23, 1933). Several examples of the practical application of this theory were presented which emphasized that progressive settlement at constant rate will take place if the bearing capacity limit is exceeded.

In the second session papers were presented by A. Casagrande (Harvard University) on "Recent Developments in Soil Mechanics," and by R. R. Philippe (Director of Soils Laboratory, U. S. Engineers' Office, Zanesville, Ohio) on "A Practical Soil Mechanics Laboratory." Professor Casagrande first discussed Dr. Terzaghi's new earth pressure theory, which takes into account those factors which determine the distribution of earth pressure against retaining walls or the timbering of excavations. By a relatively simple theoretical approach Terzaghi succeeded in evaluating the effect of arching and to arrive at results that explain the many apparently conflicting observations on the distribution of earth pressure. The speaker then discussed improvements in apparatus technique and methods for evaluating consolidation tests on clays, and of the shearing resistance of soils in general. Regarding the latter he expressed the opinion that in spite of the very large amount of research expended on this problem, little is yet known about it, particularly the shearing resistance of clays in the undisturbed state. He emphasized the importance of the volume changes which take place when soil is deformed under constant normal load. Dense sands expand their volume, a property that tends to make such materials very stable. Very loose sands and all fine-grained soils reduce their volume appreciably during shearing deformation, a property which explains many phenomena of sudden subsidence and land slides. A very fine loose sand or rock flour in a saturated state may become liquid if it is deformed, either by static shearing forces, or dynamic forces, as from vibrations due to pile driving or earthquakes.

Professor Casagrande stated that the International Conference on Soil Mechanics and Foundation Engineering which will meet at Harvard University in June, 1936, should be of great assistance to all those engaged in the teaching and practical application of this science.

Muskingum Valley laboratory

Mr. Philippe presented in his paper a very interesting account of the development of one of the largest soil mechanics laboratories in the world which is serving the purpose of design and construction of thirteen earth fill dams now being built in the Muskingum Conservancy District. He stressed the fact that no standardized testing methods are available, and that he has been forced to develop new testing machines, a work in which Professor Gilboy of M.I.T. cooperated. Mr. Philippe summed up the services which this laboratory has offered, as follows:

1. Uniform classification of the soils under consideration.
2. A clear definition of the problem involved by fixing the general physical properties of soils by routine tests (grain size, water content, etc.)
3. Reasonable estimates of seepage through earth dams and their foundations, levees, etc., and proper care against piping.
4. Tests to check the efficiency of the parts of a proposed embankment such as blankets, rock toes, drains, sumps, and cutoffs.
5. Reasonable estimates of settlements which allow the preservation of freeboard.
6. Analysis of the stability of foundations and designs conforming to the conditions met with.
7. Control of construction, uniform rolling methods, producing the maximum stability of the embankment and levees.
8. Check tests on the embankments, including analysis of the stability from slides, etc.
9. Training inspectors on construction in methods of uniform control and construction.
10. Checking and applying the results of research to prove or disprove their adaptability.
11. Soils designs based on tests which tend to satisfy inspecting officials.

A lively discussion followed the presentation of Professor Casagrande's and Mr. Philippe's papers. Among others Professor Housel brought out that, in the methods used by these two speakers, the possibility of exceeding the bearing capacity of the soil was never taken into account.

Mr. Philippe replied that in his work most investigations concerned the possibility of exceeding the shearing resistance within the soil strata below a dam, or within the dam itself, and that the procedure followed consisted of computing the distribution of shearing stresses by means of the most exact methods known, and by testing the shearing resistance of undisturbed samples of the soils in question with the most advanced testing methods. By comparing these two it is possible to know with a greater degree of accuracy whether there is danger of failure due to plastic flow, than by the method of loading tests proposed by Professor Housel, which in most cases cannot be used at all because the soil strata in question are not accessible.

Professor Casagrande also replied to Professor House's remarks, emphasizing that in his own work the possibility of plastic flow or rupture in the soil is carefully investigated whenever it is required. He stated that in most problems connected with building construction the danger of failure of the soil is very remote, and that the loading of the soil must often be limited to a very small fraction of its ultimate bearing capacity, in order to keep the settlements small enough so that they will not harm the building.

The third session was devoted to papers pertaining to the teaching of soil mechanics. D. P. Krynine (Yale University) spoke on "The Use of Models in Soils Mechanics," demonstrating a device designed for the purpose of illustrating and measuring the principal stresses in a semi-infinite, elastic body subjected to load. D. M. Burmister (Columbia University) spoke on "Undergraduate Courses in Soil Mechanics," and Professor LeRoy Tucker (Ohio State University) on "Graduate Courses in Soil Mechanics," both papers outlining how these courses are taught at the respective schools.

To continue the efforts of the society in the field of soil mechanics which were started so successfully at the Atlanta meeting, Professor Frank Kerekes (Iowa State College), chairman of the civil engineering division, appointed a special committee on soil mechanics with Professor Casagrande as chairman.

Soil-Bearing Test Values on Proportional Areas

Small test-loaded areas give data for projecting settlement curve for full footing areas of actual structure

By Marvin L. Davis
Civil Engineer, Firestone Tire & Rubber Co., Akron, Ohio

RECONSTRUCTION of a power house requiring new supporting steelwork and foundations for new and heavier power-unit replacements called for a series of soil-bearing tests, the results of which have some general interest. The work was done by the Firestone Tire & Rubber Co., of Akron, Ohio. The building is two stories, 16 ft. from basement to first floor and 52 ft. from first floor to roof. The power units are carried on the basement floor.

Plan of construction

Investigation of the existing foundations and structural framing showed that it would be necessary to replace all foundations and the entire structural system except the roof trusses. This necessitated the removal and replacement of twelve columns and their foundations. The new foundations range in size from 8½x9½ ft. to 14¼ ft. square, and the largest columns are 16-in., 264-lb. H-sections. The superimposed loads on these foundations range from 438,000 to 1,075,000 lb., with a soil-bearing load ranging from 473,900 to 1,182,500 lb.

The entire structure was shored up from the basement floor, allowing the complete removal of all the supporting steel and foundations. To expedite the erection of steel, high-early-strength cement was specified. The concrete was purchased ready-mixed, and among the items specified were that it was to develop 2,500 lb. per sq.in. compressive strength at 7 days and should contain not more than 6 gal. of water per sa of cement, including moisture con of the aggregates. Test cylind taken from each foundation poured, w broken at 7 days; the average compr sive strength of all cylinders broken w 2,615 lb. per sq.in.

Complete lack of data relative to s bearing values for the original stru ture necessitated making tests to d termine soil-bearing values for the n unit. These tests were started Feb. 1934, and were carried on continuou until March 21, 1934.

Method of testing

To determine the approximate bea ing value under large areas and attem to foretell the probable settlement of t footings under full loading, it was d

FIG. 2—LOAD AND TIME-LOAD settlement charts determined by soil-bearing tests for Ohio power house.

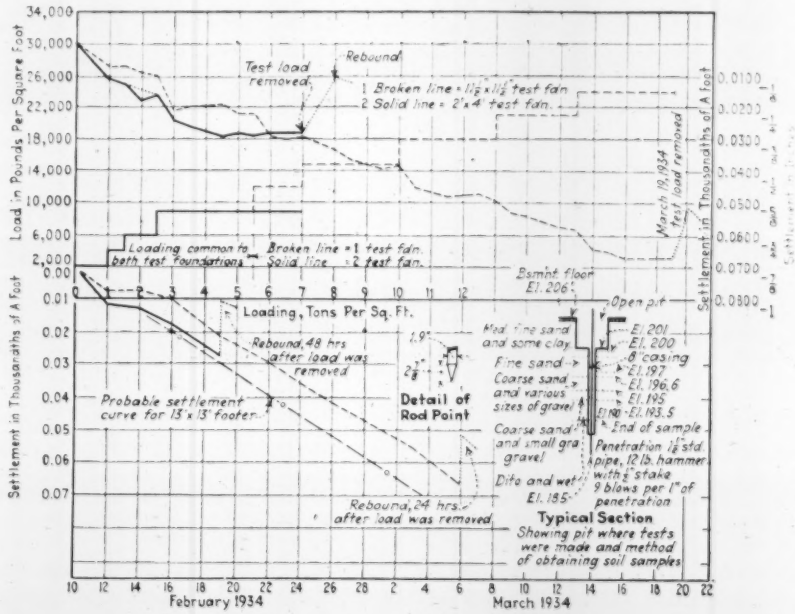
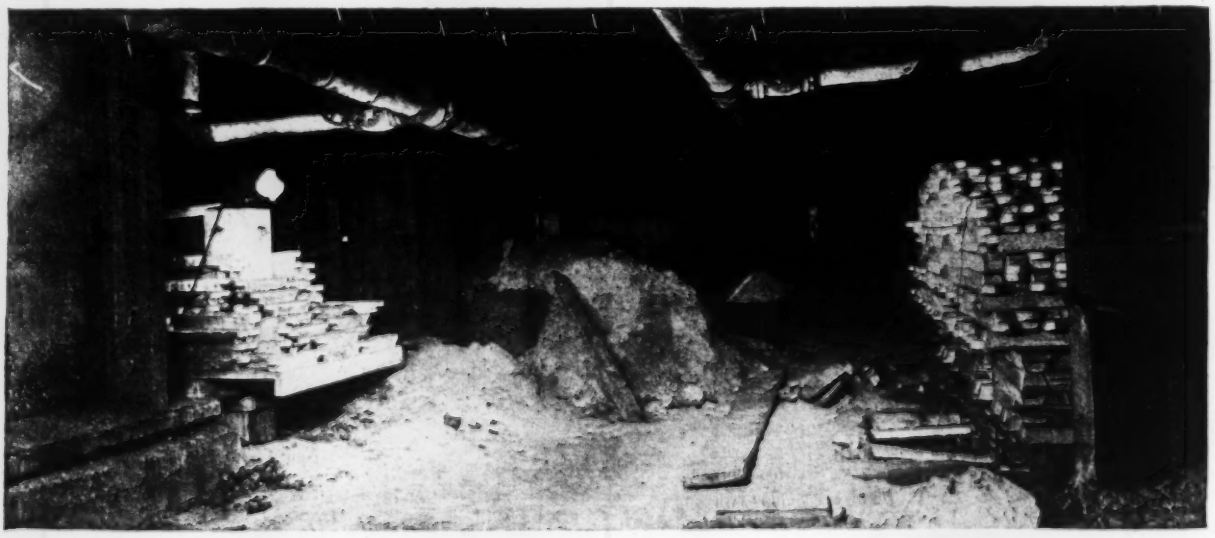

Load in Pounds Per Square Foot
Settlement in Thousandths of A Foot
Test load removed
Rebound
1 Broken line = 1½ x 1½ test fdn.
2 Solid line = 2' x 4' test fdn.
Loading common to both test foundations
Broken line = 1 test fdn.
Solid line = 2 test fdn.
Loading, Tons Per Sq. Ft.
Rebound, 48 hrs. after load was removed
Probable settlement curve for 13' x 13' footer
Rebound, 24 hrs. after load was removed
March 19, 1934 test load removed
Bsmnt floor El. 206'
Open pit
Mod. fine sand and some clay
Fine sand
Coarse sand and various sizes of gravel
Coarse sand and small gravel
Dito and wet
El. 185'
El. 201
El. 200
8" casing
El. 197
El. 196.6
El. 195
El. 193.5
End of sample
Penetration 1¼" std. pipe, 12 lb. hammer with 5' stake 9 blows per 1" of penetration
Detail of Rod Point
Typical Section
Showing pit where tests were made and method of obtaining soil samples
February 1934
March 1934

FIG. 1—TEST-PIT locations for soil-bearing determinations in Ohio power-house reconstruction.



...ded to carry out two separate tests. The bearing areas of the small and large ... piers were to each other as the area ... the larger of the two piers would be to ... full-sized footers.

Test pier 1 consisted of a wood pile, 14½ in. square, and test pier 2 consisted ... a 2x4-ft. reinforced-concrete pad. The locations of the piers are shown by Fig. 1. These test piers were loaded ... that the load per unit of bearing area ... the same on each at all times.

After the test equipment was in place, the loads were added in increments of 1 ton per sq.ft. until a loading of 3 tons per sq.ft. was reached, after which the increments were increased to 1½ tons per sq.ft. Each test load was allowed to stand until settlement ceased. The amount of settlement was then determined, and the next increment of loading was applied. This system of loading was carried out until test pier 1 had been loaded to 12 tons per sq.ft. and test pier 2 to 4½ tons per sq.ft. Loading on test pier 2 was stopped due to lack of area on which to place additional loading material.

After the final loadings had been applied and settlement had ceased, the loads were removed and the rebound was recorded immediately after removal of load, and 24 hours, 48 hours and 6 days afterward.

Results of tests

From the records thus obtained were plotted both a time-load-settlement curve and a load-settlement curve (Fig. 2). Study of the load-settlement curve shows that after the initial settlement from the 1 ton per sq.ft. loadings, the rate of settlement for both piers was practically a straight line. From the data obtained on the load-settlement curve for piers 1 and 2, it was possible to project a probable settlement curve for the full-sized footings when subjected to full loading. Based on a unit load of 6,000 lb. per sq.ft., which was developed for this soil, a probable settlement of not more than ⅜ in. was indicated.

On Jan. 22, 1935, check levels were run on all these full-sized footings, benchmarks having been established on the steel columns immediately after erection, and an average settlement of ⅛ in. was recorded, with a maximum settlement of ⅜ in. on only one footing, or an average of 33 per cent of the amount indicated on the projected settlement curve.

Soil inspection

After the loading tests had been completed and the test equipment removed from test pits, the soil conditions below the base of the test pit were further examined. An 8-in. iron pipe was driven to refusal and samples of the materials encountered were taken every foot. These samples were saved and used for making screen analyses. The soil was a fine sand with a small amount of clay from the basement-floor level to approximately 9 ft. deep. From 9 to 13 ft. the sand increased in coarseness downward, and at 13 ft. it consisted of small gravel. Effective size ranged from a 200 screen at 6 ft. to a 10 screen at 13 ft.

A further test was then made, using a test pile made of 1¼-in. standard iron pipe with a sharpened point driven with a 12-lb. hammer. This was carried to a total depth of 21 ft. below the basement floor, or 16 ft. below the bottom of the test pit. For approximate results a rule-of-thumb method was used wherein the penetration per blow of a 12-lb. sledge is substituted in the *Engineering News* formula for drop hammer, to obtain an approximate bearing value.

The method used in determining the bearing value of the soil was similar to that used by H. J. Summers in his article on "Determining Bearing Power in Earth Foundations," as recorded in *Engineering News-Record*, April 19, 1934. In this particular case, due weight was given to the soil characteristics, both as to effective size and the presence of materials in the soil other than the sand. The calculation gave the safe bearing value as 6,516 lb. per sq.ft. The loading adopted was 6,000 lb. with a safety factor of 4.

Owens Valley Aqueduct Extension Includes 11.3-Mile Tunnel

Los Angeles plans two regulation dams, also small dams and conduits to intercept and collect flow of several streams entering Mono Lake—Construction to extend over 3½-year period

FIG. 1—WEST PORTAL CAMP of the Mono Craters Tunnel, chief element of the new addition to the Los Angeles water supply, lies more than 300 miles from the city and is north of San Francisco's latitude.

SOME 350 MILES north of Los Angeles, work is under way at two portals and in two shafts of a tunnel to be 11.3 miles long, the Mono Craters Tunnel, whose purpose is to divert water from Mono Basin into the Owens River Basin. Here the supply will supplement that now conveyed to Los Angeles through the city's Owens Valley Aqueduct built many years ago. The need for this addition to the Owens Valley sources arises partly from the fact that in the past seven years 26 per cent of the water accumulated in Haiwee Reservoir, the mountain storage of the aqueduct supply, had to be pumped from wells in the valley above. In capacity, the existing aqueduct (about 480 sec.-ft.) is considered adequate for the Owens Valley water plus a regulated flow from the new source. Water brought in through the new tunnel will afford power possibilities through a head of 2,000 ft. developed in Owens River gorge, and again in the 2,348-ft. head near Los Angeles.

Supplemental to the long Mono Craters tunnel, two dams are important items in the project, one an earthfill at Grant Lake for storage and regulation above the tunnel, and the other a rock-fill at Long Valley, 16 miles below the tunnel, for storage and regulation of both Owens River and Mono Basin water. Also there will be small diversion dams and collection works, probably a concrete pipe line under pressure from Grant Lake to Mono Craters tunnel, and a steel or combination of steel and concrete line by means of which four of the five streams of Mono Basin will be made tributary to Grant Lake. Rush Creek flows directly into Grant Lake Reservoir.

FIG. 3—GRANT LAKE DAM will replace the water-worn cut through the glacial moraine in the center of the view. Background shows typical Mono Basin topography.

The tunnel will have a wide horseshoe cross-section 9 ft. in diameter inside the concrete lining, and will be advanced from six headings—the two portals, and two shafts put down at intermediate points. Shaft 1 will be 950 ft. deep, and Shaft 2, 350 ft. They have an identical cross-section; each containing two 5x5-ft. skipways, a 2x5-ft. manway and a 4x5-ft. pipeway.

Borings along the line of the tunnel indicate that some 10 miles of the total length will be in water-bearing strata. However, up to the middle of April, advances exceeding 2,000 ft. at the west portal and 1,000 ft. at the east portal had encountered very little water. Nor had serious water difficulty been met in work on the shafts up to that time. The formation is wholly igneous, including compressed pumice, various granitic formations and tufaceous lavas with some sand and gravel.

From the west portal to Shaft 1 the length will be 24,447 ft., between the shafts 22,620 ft., and between Shaft 2 and the east portal 12,745 ft. At the west portal the first camp was established, and work was carried underground late in the fall of 1934. The tunnel-driving schedule, based on an estimated average progress of 7 ft. per shift, contemplates final completion of the tunnel in 1938. Practically all the work is carried on by the city as a force-account project. With the time required for tunnel driving as the governing factor, all phases of the project are planned for simultaneous completion.

Grant Lake Dam will be about 90 ft. high, will raise the water level 70 ft. and will have side slopes of 2½:1 on the main body of the embankment. The slope upstream will be flattened to 7:1 toward the base, to increase the length of the path of percolation beneath the structure. The top width of the rolled earthfill will be 30 ft., and the bottom width about 600 ft. The total volume of placed material will be 490,000 cu.yd., of which about 360,000 cu.yd. will be rolled fill. Instead of concrete paving on the upstream face, the larger rock segregated from the fill material and obtained from spillway excavation is to be deposited there to prevent the wash resultant from wave action. Active construction on Grant Lake Dam was begun late this spring. A pressure conduit delivering water from Grant Lake Reservoir to Mono Craters Tunnel will have a capacity of 500 sec.-ft. when operating under the full head of the reservoir.

Long Valley Dam, about 16 miles below the tunnel, will be a rockfill structure 145 ft. high above stream bed and 520 ft. long on the crest. In addition to the Mono Basin water, it will control runoff from the upper 437 square miles of the upper Owens River drainage basin, at a point about 57 miles above the Owens River Aqueduct intake. Exploratory work at Long Valley Dam site was done some years ago, and these records are being supplemented with

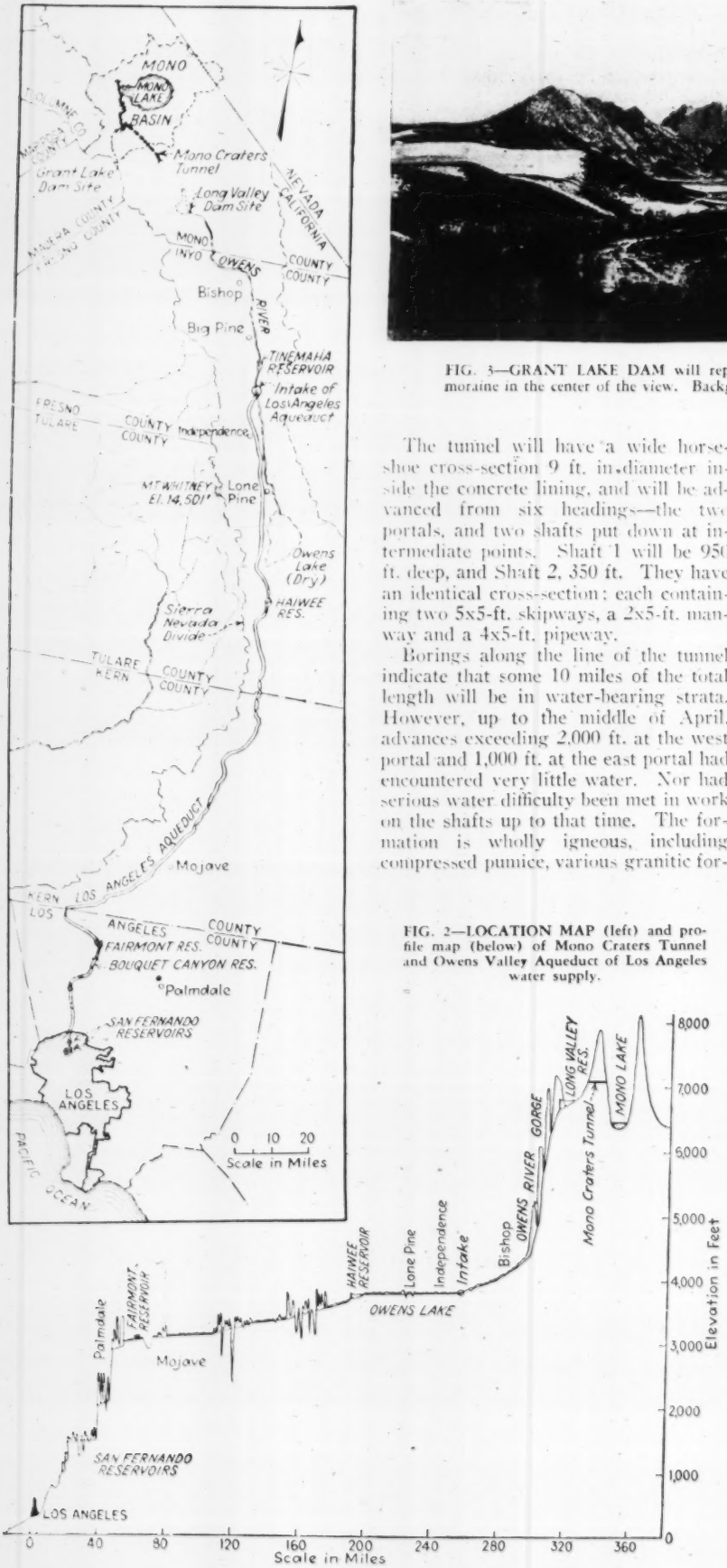


FIG. 2—LOCATION MAP (left) and profile map (below) of Mono Craters Tunnel and Owens Valley Aqueduct of Los Angeles water supply.

core-drill borings started in April of this year. Additional preliminary work on this structure is now under way with a view to the start of active construction early next year.

The project as a whole, exclusive of land and water rights, is estimated to cost $8,800,000, and construction is to extend over a period of about 3½ years. Construction of the collection and connecting conduits in Mono Basin is to begin in the spring of 1936.

The project is under the general direction of H. A. VanNorman, chief engineer and general manager, bureau of waterworks and supply, city of Los Angeles. H. L. Jacques is construction engineer, E. A. Bayley is engineer of surveys, and Hugh Mulholland is general superintendent on the Mono Craters Tunnel.

Old-Time Continuous Mixer Used for Concrete Tunnel Lining

Concrete equipment on Chicago water tunnel ranges from old-fashioned mixer to modern ingenious belt-conveyor distribution system — Crusher-run aggregate utilized

By Frank Rasmussen
Engineer, Link-Belt Company, Chicago, Ill.

FROM out of the past of 40 years ago the old continuous paddle concrete mixer has been revived and combined with an ultra-modern belt-conveyor distribution system, to create a strange but effective array of equipment for use in lining the Chicago Ave. water tunnel in Chicago. This type of mixer, popular in the last two decades of the 19th century, but practically unknown today, was selected because of limited clearance in a 16-ft. bore, where muck cars had to be operated through the concreting equipment. Another departure from the present-day precise control of concrete manufacture is the use of crusher-run limestone aggregate crushed from the tunnel muck, in the ratio of 1 part of cement to 3 of aggregate.

Water is admitted to the mixer through a perforated pipe without measuring. Despite the unorthodox method of proportioning and mixing, a satisfactory quality of concrete is being obtained. A strength of 2,000 lb. in 28 days is desired, and daily test cylinders are breaking from 2,000 to 6,700 lb.; 12-in. calyx drill cores, taken from the lining at 300-ft. intervals, show corresponding strengths.

Day-labor operations

Driving of the tunnel and its branches has been under way for some eight years by day-labor forces under the direction of the city engineering department. Scraper mucking methods, the principal feature of mining operation, were described in *ENR*, May 26, 1927, p. 860. The main tunnel, a straight-side circular-arch section 16 ft. in diameter, extends 193 ft. below mean-lake level from a new crib east of the Carter H. Harrison crib, southeast to Two-Mile crib, and thence westward, reaching the mainland at Chicago Ave., 2.7 miles from the crib. The tunnel continues west under Chicago Ave. for 5.1 miles. A 10-ft. branch, 1.4 miles long, leads northward to the Springfield Ave. pumping station, and a 13-ft. branch, 1.8 miles long, connects with the Central Park Ave. pumping station to the south. Progress has been interrupted from time to time, more recently by a controversy over cement prices, but it is now again under way, and completion is expected this summer. Excavation was completed with the final holing through on Feb. 25, 1935.

Mixing plant

The mixing plant consists of two units—a batch feeder and a continuous mixer. Both units are mounted on a wide-gage jumbo straddling a single

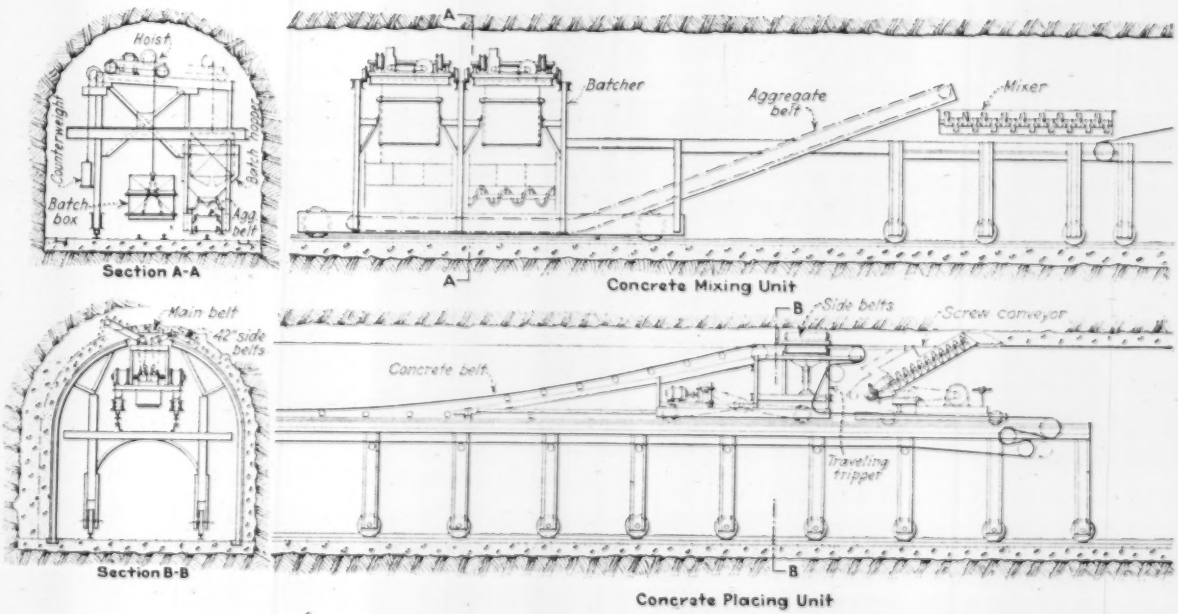


FIG. 1—DIAGRAMMATIC SKETCH of batching, mixing and placing units on Chicago Ave. tunnel lining. The lining equipment is a curious array of old and modern units, ranging from a paddle mixer to a belt conveyor that dumps the concrete directly into the side forms.

FIG. 2—GANTRY HOISTS transfer batch boxes from cars to hoppers at left as first step in mixing operations for Chicago Ave. tunnel lining.

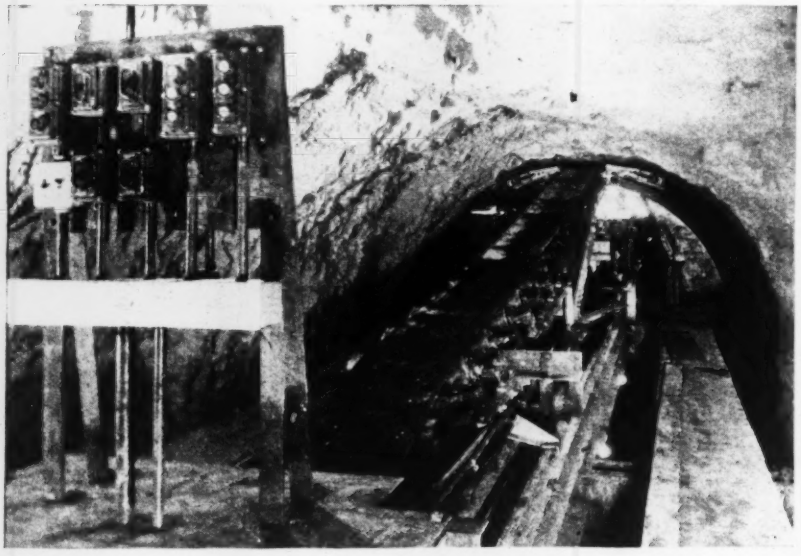


FIG. 3—CONTROL PANEL of the placing unit and the inclined lead of the traveling tripper rig. Concrete from the continuous mixer is carried up this belt into the top of the form.

narrow-gage track over which muck trains operate (Figs. 1 and 2). The batching unit consists of two V-bottom hoppers set end to end along one side of the jumbo over a belt conveyor. Each hopper—one for aggregate, the other for bulk cement—is served by an electric gantry hoist of novel design. Cement and the crusher-run aggregate are each brought into the tunnel by way of a shaft, in 2-yd. bottom-dump bodies set on car trucks. The gantry hoists lift the batch bodies off the truck and move them transversely over the hoppers, where the contents are dumped. The gantry rails are set at a pitch toward the hoppers, permitting the transverse movement to be made by gravity. A counterweight pulls the hoist with empty batch boxes back to position over the track.

Gates on the bottom of each hopper bin regulate the flow of material onto the apron conveyor. Aggregate is discharged from the first bin, and a fixed plate plows a groove in the aggregate stream, which receives the cement from the second bin. The conveyor is of the apron type, 18 in. wide and 65 ft. long. Once set, the gates seldom need adjustment to provide a uniform and correctly proportioned flow of material.

Continuous mixer

The materials belt discharges into one end of the continuous mixer, which is set on a high traveling jumbo connected to the batcher jumbo. This mixer is a U-shaped trough of ⅜-in. manganese steel plate, 20 in. in diameter and 14½ ft. long. Mixing action is provided by 50 paddles mounted on a square shaft, set at a pitch to propel the mixture forward. The paddles are of 2 per cent manganese steel alloy with edges cast smooth. Electrically driven, the paddle shaft operates at speeds varying from 27 to 55 r.p.m.

The mixing action is continuous. Materials enter one end in a steady stream, and mixed concrete is discharged in a steady flow at the opposite end. Water is introduced through a perforated pipe running longitudinally above the trough. It is not measured but is applied as required by observation of the operator. With the mixer discharging at the rate of 50 cu.yd. per hour, the contents remain in the trough for 1 min. But frequently the rate of discharge is speeded up to 84 cu.yd. per hour, which correspondingly reduces the time of mixing.

Invert poured ahead

The first step in placing a lining is to pour the flat invert often weeks or even months ahead of the side walls and arch. Concrete for the invert is dumped from the mixer into chutes for direct placement. Along each side wall is cast a square trough or gutter, the outside line coinciding with the finish line of the future side walls. These gutters provide a recess into which the side-wall forms are later set, with the lower face jacked tight against the inside gutter face (Fig. 5).

Concrete placing system

The side wall and arch lining is placed by an ingenious combination of belt and screw conveyors, operating continuously to take the steady flow of concrete from the mixer. This equipment is also mounted high on a traveling jumbo that moves along with the batcher and mixer. The first unit of the placing equipment is a 20-in. troughing belt conveyor 176 ft. long, operating at a belt speed of 320 ft. per minute (Fig. 3). This conveyor uses a 4-ply, 20-oz., duck rubber-covered belt, running over 6-in. three-roll trough idlers and single-roll flat-belt return idlers.

The belt runs over a novel tripper which consists of a traveling frame with an inclined lead, the whole rolling longitudinally on tracks set on top of the jumbo. The top horizontal section of the tripper sets high in the arch form, in the space later occupied by the crown form section. In this top section the troughing idlers are replaced with flat rollers.

For the side walls and lower part of the arch section the concrete is plowed off the belt, to either or both sides, by an adjustable blade. This plow diverts the concrete onto two short 42-in. belt conveyors running at right angles to the tripper belt. Concrete is thus transferred from the main 20-in. belt conveyor sidewise into the side-wall form. The transfer belts, running at a speed

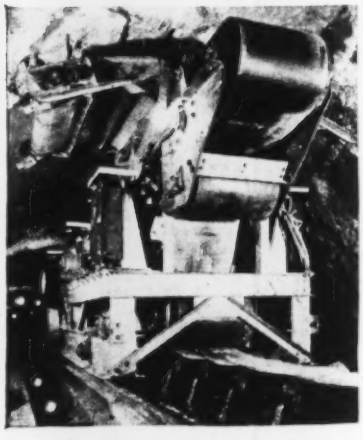


FIG. 4—TRIPPER END of the placing unit, showing the novel side belts for distribution of concrete into the side forms. The entire rig moves back and forth through the form section during pouring of the side walls and arch.

ft. per minute, are on a jointed ...rk, to permit turning downward ... reach farther into the side-...rms (Fig. 4). At first there was ...oubt as to how the 42-in. cross-...ould function. However, they ...roved very successful and dis-... the concrete farther into the ... than was originally expected.

... filling the sides and arch, the ... is moved by its own power back ...th along its track, to keep the ... fill fairly level. An arrange-... of idler pulleys at the forward ... of the tripper keeps the belt tight ...gardless of the position of the traveler.

Filling the crown

... a form section is poured nearly ... crown level, another ingenious ... is brought into use for filling ... section. The tripper is pulled ... enough to permit installation ... crown plates in the form. Then ... is raised, allowing the concrete ... discharge off the upper end of the ... belt into a hopper at deck level ... the jumbo. An inclined screw con-... leads from this hopper up over ... of the crown form and a short ... into the key void (Fig. 6).

The screw conveyor was developed ... a series of experiments at the ... shaft of the tunnel with a con-... that the city had on hand. It was ... desired that the screw would ... the concrete into place with some ... This proved impracticable be-... the pressures soon built up to a ... where the screw failed to function. ... the concrete is delivered on ... of the key plates, whence it is ... into place by hand tampers.

The equipment described above is ... used on the 16-ft. main tunnel ... the 13-ft. branch. On the latter, ... of limited clearance, a gib crane ... the gantry hoist for dumping ... aggregate and cement car bodies ... the batch hoppers. On the 10-ft. ..., clearance limits prohibit the ... of the belt-conveyor system of ..., and regular pneumatic place-... machines are being used.

Steel forms

The standard form section is 97 ft. ... It consists of two rigid shells, ... a complete side wall and half arch ... up to the key section. These shells ... mounted on the same jumbo that ... the concrete placement equip-..., and are so arranged that they ... be set or struck by moving out and ... on a line 30 deg. with the horizontal ... means of a hand winch. The key ... sections are placed one at a time ... final filling operations progress, and ... stripped complete before the re-...der of the form is struck.

... are struck, moved ahead, set ... filled in one eight-hour shift, and ... in place at least twelve hours. ... and resetting usually takes about two hours, and the 320 cu.yd. of concrete required for the 97-ft. length of side walls and arch are placed well within the remaining six hours of the shift. The concrete crew is paid for a full shift even if they finish a pour under eight hours, and this time-bonus system has resulted in building up of efficiency and morale among the workers.

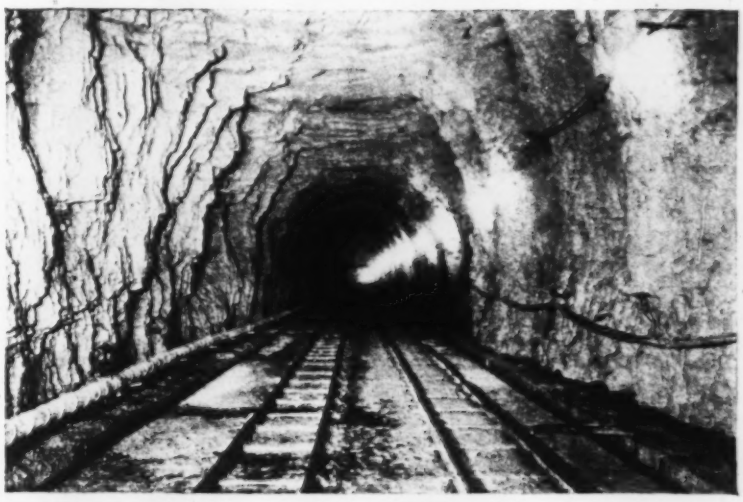


FIG. 5—SECTION OF TUNNEL with the invert poured far ahead of the remainder of the lining. The slots or gutters at either side receive and hold the lower edges of the side forms.

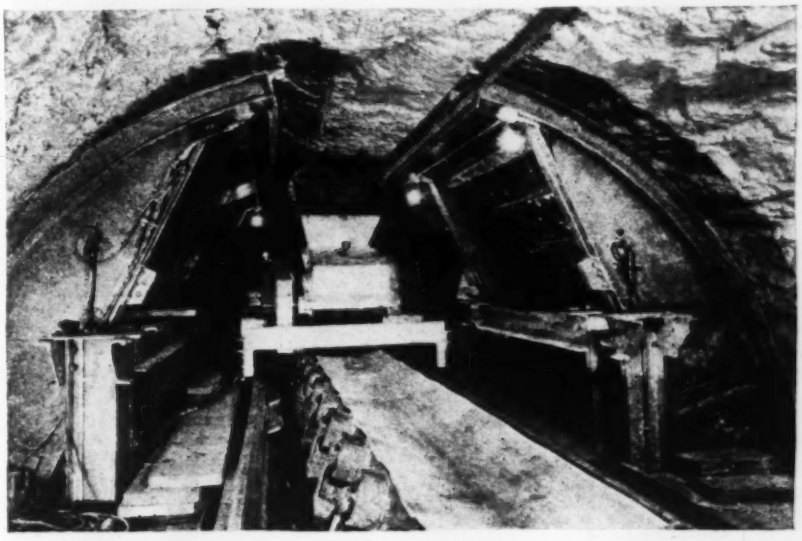


FIG. 6—KEY SECTION of the arch is concreted by an inclined screw conveyor, which receives the mix from the end of the tripper belt.

Direction

The Chicago Ave. tunnel is being built by day labor by the city department of public works under the supervision of Mayor Edward J. Kelly, Oscar E. Hewitt, commissioner of public works, Loran D. Gaynor, acting city engineer and James J. Versluis, engineer of waterworks construction. The lining equipment was designed by Mr. Versluis in collaboration with engineers of the Link-Belt Company, which furnished the equipment.

Fort Knox Chosen as Site for U. S. Treasury Vault

A test pit to determine the depth of bedrock was begun at Fort Knox, Ky., on June 29 as the first step in a program to construct a government vault in which to store much of the gold now held in the Treasury at Washington.

At the same time a survey is being conducted to obtain topographic information. Plans announced by the Treasury Department call for an expenditure of $450,000, which will include the erection of an office building over the underground vault.

Moisture in Concrete Sand Measured by Electric Current

Experiments and trial installations at Alton lock and dam show an accuracy within three-tenths of one per cent in determining moisture by electrical conductivity of sand

By Chas. E. Wuerpel
Assistant Engineer, U. S. Engineer Office, Alton, Ill.

ACCURATE knowledge of the free moisture present in aggregate is one of the most difficult problems in maintaining a given water-cement ratio in field concrete. Under the existing U. S. Engineer Department specifications, requiring proportioning of all materials by weight, this problem is of considerable importance because it affects the true weight of the sand and stone required in the mixture as well as the amount of water to be added to obtain the total water content. A number of methods have been evolved for determining free moisture, all of which have the disadvantage of requiring either considerable time or elaborate equipment. The methods most generally used require from 5 to 20 min. for a moisture determination. As a result the usual determination is merely a check on the amount of moisture in some previous batch of material and only enables the operator or inspector to approximate the moisture present in succeeding batches. In addition to this material disadvantage, determinations by the usual methods may not be performed as frequently as they should be.

On projects where the aggregate, sand particularly, is fed directly from barges or cars to the mixer storage bins the moisture content of the aggregate may vary frequently and materially. During the construction of U. S. Twin Locks No. 26 in the Mississippi River at Alton, Ill., involving the placement of about 204,550 cu. yd. of concrete, this unstable condition of moisture has been at a maximum during portions of the winter months, due to the use of bottom-dump gondolas feeding directly to the storage bins and the necessity for occasionally using live steam to thaw the aggregate frozen in the cars and bins. During the past winter season it was not unusual for the moisture content of the fine aggregate to vary several per cent within two or three batches. The moisture content of the coarse aggregate varied, too, but due to the inability of the crushed stone to hold more than 1.75 per cent moisture the effect of the fluctuation was not as difficult to control. During the summer months and on projects where sizable stockpiles are maintained, the fluctuation of [illegible] is minimized, but there are [illegible] where immediate knowledge of [illegible] content is of considerable valu[illegible]

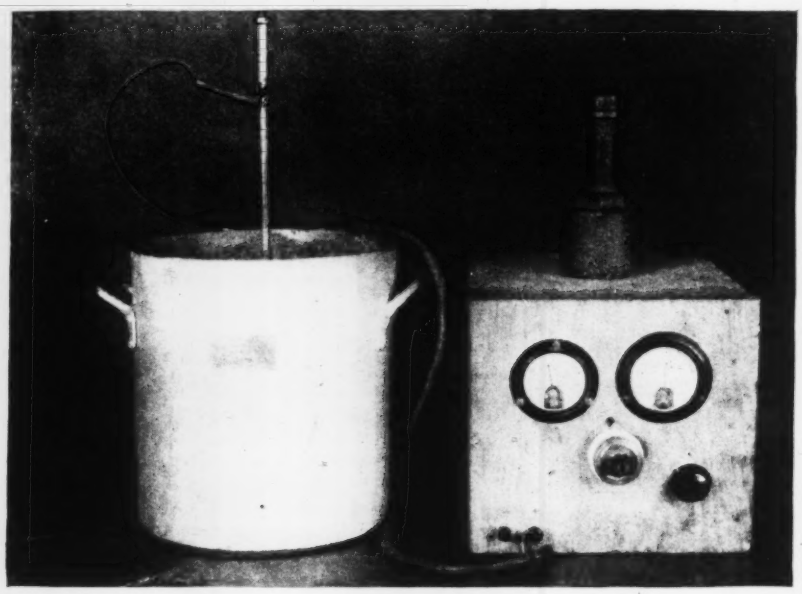


FIG. 1—ELECTRICAL MOISTURE-TEST APPARATUS for laboratory calibration of field apparatus in service at Alton locks includes a ½-cu.ft. sand container and 10-lb. tamper

Electrical determination tried

During the period when great[er] difficulty was experienced in maintain[ing] concrete of a uniform consistency [at] Lock No. 26, it was decided to experiment with a method of determining the free moisture contained in the fine aggregate by means of electricity. The method is based upon the assumption that the electrical conductance of moist sand increases with increase in percentage of moisture present. Provided the dry sand remained reasonably constant in physical characteristics and the degree of compaction of successive batches did not vary perceptibly, any variation in current flow between fixed electrodes, at a constant voltage, would be a function of the moisture present in the sand. The sand used in the construction of Lock No. 26 is all obtained from the mouth of the Missouri River and is sufficiently constant in mineral and physical characteristics. The weigh-hopper at the mixing plant was chosen as the locality in which a constant volume under constant compaction could most practicably be obtained.

The details of the apparatus and installation in the sand weigh-hopper are shown in Fig. 2. The center electrode consists of a ⅛x5x22-in. steel plate suspended within the hopper on two heavily insulated spacer rods. The steel sides of the bin form the second electrode. Leads were run to a test set consisting of a 0-110 volt voltmeter (direct current), a 0-110 milliameter and a switch. The circuit is activated by a 90-volt bank of radio B batteries mounted in the test-set box.

To establish the equivalent electrical conductance for a wide range of moisture in the sand, tests were made by reading the current flow at 90 volts, in milliamperes, through succeeding batches of sand in the weigh-hopper. At the time of each electrical reading a representative sample of the same batch, weighing 2,000 grams, was withdrawn, its temperature recorded, and the actual moisture content determined by drying. This test procedure was repeated as rapidly as the drying tests could be completed. Over a period of about three weeks more than 200 such parallel tests were made under decidedly varying conditions of moisture. From the results of these tests the curve A in Fig. 3 was drawn. The limits of the individual tests indicate that the method is generally accurate to within 0.3 per cent moisture, with occasional variations of not more than 0.7 per cent moisture. In determining the free mois-

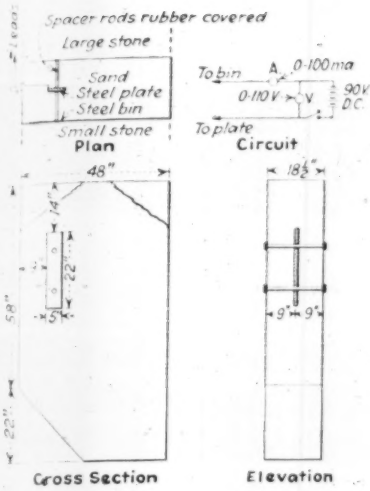


FIG. 2—ELECTRICAL CIRCUIT of moisture-determination installation utilizes a plate in the sand bin for one electrode and the steel bin wall for the other.

ture in fine aggregate the percentage of absorption is deducted from the total apparent moisture present. The sand used at Lock No. 26 has a factor of absorption of about 0.7 per cent. This value is compensated for in all electrical moisture determinations in the field and in the laboratory.

During the two months following the adoption of this method of electrically determining the moisture in the fine aggregate it has been found that the consistency of the concrete is more uniform and control of the water content much simpler. A table has been prepared that contains the current flow in increments of 2 milliamperes with equivalent moisture in terms of percentage, actual pounds of water present and the corrected weight for the water scale. The use of this chart attached to the test set at the mixer provides immediate knowledge of the water present in any batch of sand. It is felt that whatever inaccuracies exist in this method are compensated for by the rapidity and simplicity of the test, as the immediate results obtained permit instant detection of moisture variation.

Checked by laboratory studies

To determine the effect of several variables upon the results of this method of electrical moisture determination, the following were investigated in the concrete laboratory: (1) differences in conductance of water from various sources; (2) effect of temperature upon the conductance of waters and moist sands; and (3) effect of gradation upon the conductance of moist sands.

The test for the laboratory investigations was essentially the same as that used at the mixer. Because of the considerable variation in conductance of the various materials to be tested, it was found necessary to control the voltage by inserting a variable resistor in the circuit, so that the current flow would remain within the range of the milliameter. In view of this variation in voltage it was necessary to resolve the results obtained in terms of ohms resistance, obtained by the formula $R = E/I$.

Conductance of materials

The first series of tests determined the conductance of distilled water, Missouri River water, and tap water from the Alton city supply, at varying temperatures. The apparatus used for these tests consisted of a 600-c.c. Pyrex beaker containing two sheet-copper electrodes attached to the test set. The results shown in Fig. 4 indicate considerable difference in the conductance of the various waters, particularly at the lower temperatures. Individually, however, the variation in conductance was fairly consistent with respect to change in temperature. As the results of this series showed the greatest difference in conductance to exist between distilled water and tap water, it was decided to use these two extremes to determine their effect upon the conductance of the sand containing varying degrees of moisture at a constant temperature.

For determining the electrical conductance of moist sand in this second series, a ½-cu. ft. cylindrical bronze measure (10 in. in diameter and 11 in. in depth) was used as the container and as one electrode; a ⅜-in. sherardized steel rod was used as the other electrode (Fig. 1). A quantity of representative sand was obtained from the mixer and dried to a constant weight. The percentage of absorption was checked. The dried sample of sand was then sieved to determine the exact gradation, and a 60-lb. sample at room temperature (75 deg. F.) was placed in a galvanized-iron washboiler. Water, at room temperature, was then added and thoroughly mixed with the sand, the mixture then being loosely scooped into the bronze container and struck off level with the top without compacting. The rod electrode was then inserted in the center to a depth of 8½ in., and the sand was tamped 25 blows with a 10-lb. circular weight dropped from a height of about 3 in. with as little disturbance of the rod electrode as possible. The test set was adjusted to the desired voltage and the milliameter read. This process was repeated in increments of 0.5 per cent to a total of 7 per cent moisture. The entire series was repeated three times with each type of water, and the results were plotted as shown in Fig. 5A. As a rapid check of the results obtained with the large bronze container, a smaller apparatus was devised consisting of a circular copper pan with sides about 1

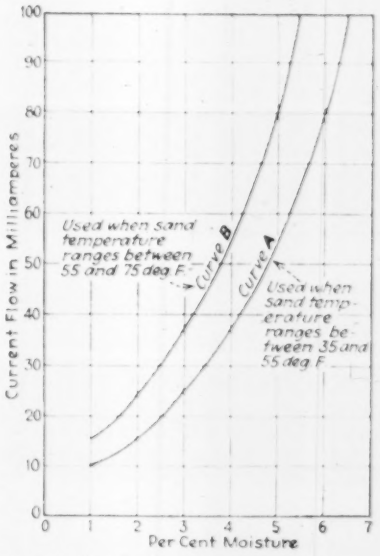

Current Flow in Milliamperes
Per Cent Moisture
Used when sand temperature ranges between 55 and 75 deg. F.
Curve B
Curve A
Used when sand temperature ranges between 35 and 55 deg. F.

FIG. 3—MOISTURE-CONTROL CURVES calibrated for Missouri River sand used at Alton locks; accuracy 0.5 per cent; absorbed moisture compensated for.

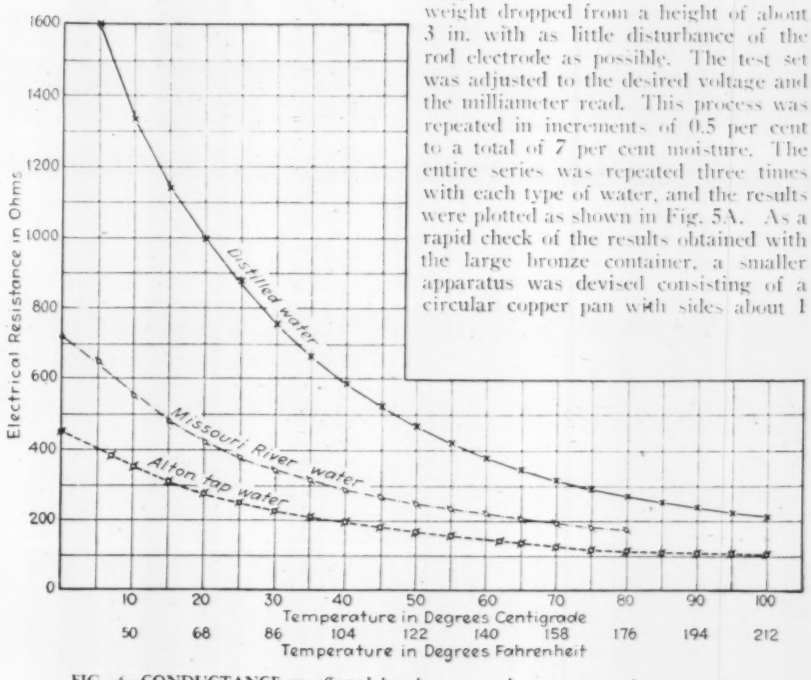


FIG. 4—CONDUCTANCE as affected by character and temperature of water; tests made on water alone.

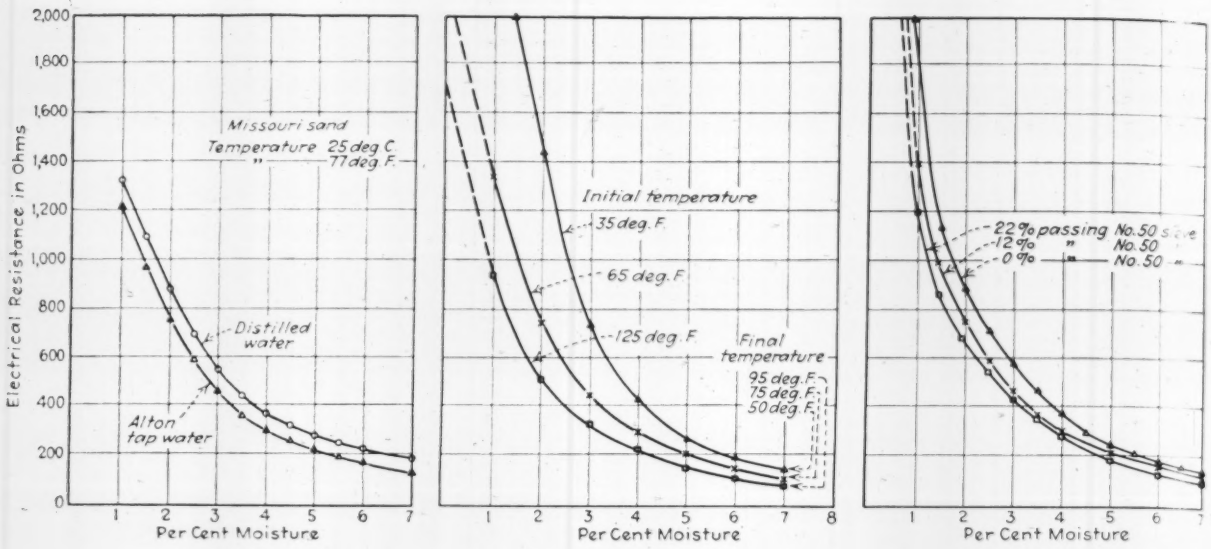


FIG. 5—CONDUCTANCE of wet sand as affected (A) by type of water, (B) by temperature, and (C) by gradation of sand.

in. high into which was fitted a glass cylinder 6 in. in diameter and 7 in. high. Then 1,000 gr. of dry sand was placed in the container, the desired water added, thoroughly mixed and leveled off. A circular copper plate 5 in. in diameter was placed on top of the sand and weighted down by a superimposed 40-lb. weight. The copper pan and plate served as the electrodes. The results of these tests checked those obtained with the bronze measure.

From the results shown in Fig. 5A, it is apparent that although the curves representing the two types of water present in the sand are parallel, the apparent moisture as determined by an equal resistance varies up to 1.5 per cent moisture at 200 ohms. These two cases are extremes, and local variation in type of water present in the sand at the mixer due to rain, melting snow or to steam, adding to the normal river water present, could not be so great. It is believed that irregularities in the moisture determination from this cause would not be appreciable. This conclusion has been borne out at the mixer.

Fig. 5B shows the effect of temperature on the electrical conductance of moist sand. In this series tap water was used. Due to lack of adequate facilities for maintaining a constant temperature, the curves in Fig. 5B range in temperature as shown. From these results it appears that temperature must be taken into consideration in the electrical determination of moisture in fine aggregate. A difference of 30 deg. would vary the results by 0.5 to 1.0 per cent of apparent moisture. For practical purposes it is believed sufficient to establish curves for moisture at temperatures varying from 35 to 55 deg., 55 to 75 deg., and from 75 to 95 deg., making the calibration tests at about 45, 65 and 85 deg., respectively.

Curve A in Fig. 3 was established at a time when the sand temperature ranged between 35 and 55 deg., with most of the points being established at about 45 deg. Curve B has been more recently established from calibration tests at the mixer with sand temperatures ranging from 60 to 70 deg., with most of the points being established at about 64 deg. As the temperature rises during the sumer months an 85 deg. curve will be established.

To determine the effect of gradation on the electrical measurement of moisture in sand, one test each was made on the coarse and excessively fine sand. It is not believed that a definite conclusion may be drawn from the result (Fig. 5C) of only one test, but it seems indicated that differences in gradation will offer no serious difficulties in this method of moisture determination, because the cases taken are extreme and not likely to be encountered.

Conclusion

All the above tests were performed as accurately as possible with the limited facilities at hand. The effort was to determine general tendencies rather than to establish definite laws. There is no doubt that ionization and other electro-chemical phenomena have a considerable effect upon the measurement of flow of electric current through liquids and moist media. (For a discussion of this see Gemant's "Liquid Di-Electrics," John Wiley & Sons, 1933.) With the limited time and equipment it was believed best to avoid as far as possible the intricacies of such problems. In performing the laboratory tests it was impracticable to simulate conditions of compaction, contact area of electrodes or electrode spacing, and length of leads as they exist at the mixer. This fact does not detract from the value of the tests because a check of the mixer graph was not so much desired as was the comparison of the factors that might influence the results. It is evident that each project on which this method is adopted requires an individual calibration using the type of sand, water, batch-hopper, type of electrode and length of leads that will be used for that work. This calibration can be accomplished in a comparatively short time but should be sufficiently comprehensive to cover a wide range of moisture. This method permits considerable latitude in choice of apparatus, the essential point being to measure current flow at a constant voltage through a fixed area, or volume, of uniformly compact material. The fact that the laboratory work and continued check of the results of the electrical method at the mixer confirmed the results obtained initially at the mixer, and also that it is consistent with general physical laws, gives assurance that the electrical determination of moisture has much to recommend it.

Booneville Dam Ranks Third As PWA Work Provider

Ranking third among the federal dam projects as a work provider, the Booneville Dam being construct d by Army engineers on the Columbia River has been responsible, through the expenditure of PWA funds, for the creation of approximately 25,000,000 man hours of employment. This figure is embodied in a report recently made public by the PWA of the employment provided so far by the expenditure of approximately $13,000,000 on the dam.

The dam, which is to cost $40,200,000, and which has been allotted $32,200,000 by PWA, is already 32 per cent complete. About 40 per cent of the PWA allotment, permitting construction to start in December, 1933, has already been spent.

Cement, Timber, Brick and Asphalt Specifications and Tests

Second half of A.S.T.M. convention program at Detroit records important developments in a number of prime construction materials

THE STRONG REVIVAL of interest in materials testing and research noted in connection with the first half of the program of the meeting of the American Society for Testing Materials in Detroit two weeks ago (*ENR*, July 14, 1934, p. 20), continued in evidence during the later sessions covering such construction materials as cement, concrete, timber, brick and asphalt. Cement studies continue along lines of special cements, and a proposal to re-examine the adequacy and pertinence of the definition of standard portland cement won approval after a close vote. Concrete durability is rapidly becoming the prime field of study for cement and concrete technicians, and some significant research on shrinkage was reported. The physical properties of wood for structural service continue under close scrutiny, and the proposal was made to replace grade marking classifications with stress values in the specifications. Mortars for brick masonry are receiving long-overdue attention by virtue of the advent of reinforced brickwork. Asphalt is being studied as a material with definite elastic properties, and important progress is being made in soil research. These statements are developed in the report of the meeting which follows.

Cement

The decision to appoint a committee to examine critically the long-standing definition of standard portland cement, and the consequent refusal of the convention to advance the high-early-strength portland cement specification from tentative to standard status until the conclusions of this committee are known were the outstanding developments in the cement session. The unanimous vote to appoint the portland cement definition committee followed an extended exposition on the need for a change in the definition by Bradley Dewey of the Dewey & Almy Chemical Co., Cambridge, Mass. Mr. Dewey contended that the present definition which narrowly limits the materials that may be used in manufacturing portland cement does not in fact exclude "contaminations" which either enter unavoidably or are added purposefully. Mr. Dewey was supported in this view by several members. In closely restricting the ingredients of portland cement, the present definition either obstructs progress or invites circumvention, in Mr. Dewey's opinion, and he favors a definition which only requires ingredient materials to pass definite tests and which only prohibits substances known to be deleterious, in other words, one that emphasizes "the results and not the process."

When the high-early-strength portland cement specification came up for decision on advancing it to standard, it was voted down on the basis that it was inconsistent to make a specification standard which contained a definition that possibly might be changed. The specification continues as tentative. Since no vote was taken on the deletion of the fineness requirement, as proposed in the revised specification which was rejected, fineness presumably remains a factor in the existing tentative specification. In his report as chairman of the sponsoring committee, M. A. Swayze (International Cement Corp.), outlined some of the results of tests in four laboratories on the 33 high-early-strength portland cements now on the market. All of these cements were tested for fineness and in addition comparative tests were made using standard briquets, plastic mortar cubes and 6x12-in. concrete cylinders. The tensile strengths of the briquets proved to be remarkably uniform as were the compression strengths of the concrete cylinders. On the other hand, a surprising variation in mortar cube compression strength was noted.

Later in the session the subcommittee on plastic mortar also reported that it had encountered difficulties in securing uniform results with mortar cubes. Mr. Swayze stated that additional specifications for those high-early-strength cements which are mixtures of portland cement and small quantities of other materials are being considered.

Work has continued on low-heat and blended cements, but no specification recommendations were made. It was pointed out that while agitation regarding low heat cement had somewhat subsided, the opposite was the case with blended cements. The investigation so far on blended cement has concerned portland puzzolana cements only. Of the four standards proposed by the cement committee for publication as tentative during the year, those on chemical analysis of portland cement and testing for fineness by means of the turbidimeter have been issued. Approval of the other two proposed standards, on sulfate-resistant portland cement and on methods for testing and sampling sulfate-resistant portland cement, has been withheld pending receipt of more supporting data.

Concrete durability

Durability of concrete was the general theme of three papers by H. S. Mattimore (Pennsylvania State Highway Department), R. W. Carlson (Massachusetts Institute of Technology), and Inge Lyse (Lehigh University) respectively. Mr. Mattimore outlined an investigation of the durability of 45 experimental concrete headwalls installed 4½ years ago in a vicinity where other headwalls, although built in accordance with good engineering practice, failed within a year. In the experimental headwalls, two different sands, two different cements, and the same coarse aggregate were used, with different mixtures and different water-cement ratios. Careful periodic inspections were made and the degree of disintegration of the walls was estimated. Relatively poor results were obtained with certain combinations of the cements and sands, in spite of the fact that there was no major difference in the chemical analyses or the calculated compounds of the two cements, with the exception that the tetracalcium alumino ferrate (C_4AF) in one case was 10.2 and in the other 6.3 per cent of the total. There was also a noticeable difference in the alkali content of the cements, although the total amount of alkalis involved was very small. The sands differed principally in the sodium sulfate soundness test, one sand losing 17.3 per cent and the other 5.2 per cent. In general the wetter mixes were less durable than the dryer mixes, and the rich mixes showed lower structural ratings than did the leaner mixes. Mr. Mattimore suggested that further study be given the C_4AF and alkali contents of cements to be used in concrete subjected to extreme exposure and rapid alterations of temperature. Successful results with the poorer cement in other locations seem to indicate that the headwall locations present a special problem, probably requiring a special cement. The pH values of the soil in the test locations indicated that the soils were practically neutral, so that acid or alkali action was not held to be a factor in this particular disintegration.

Professor Lyse presented the results of an investigation of volume change on 3x6-in. concrete cylinders which go a long way toward explaining shrinkage of concrete. This shrinkage was found to be practically proportional to the paste content and not materially affected by the quality of the paste or the length of moist curing. If the shrinkage is directly proportional to paste content, every factor that tends to decrease the paste also tends to reduce the shrinkage. According to Professor Lyse this accounts for the fact that lean mixes

shrink less than rich mixes, that concrete shrinks less than mortar, that dry mixes shrink less than wet mixes, that concrete of low sand content shrinks less than concrete of high sand content, and that concrete with coarse sand shrinks less than concrete with fine sand. Also, concrete having well graded aggregate shrinks less than concrete having poorly graded aggregate, and the addition of powdered admixtures would in general be expected to increase the shrinkage. Professor Lyse's investigation also covered some high-early-strength portland cements, which produced more shrinkage than the standard portland cements, particularly in the lean mixes, although in terms of shrinkage per unit of strength, the high-early-strength cement was the superior.

The conclusions of Professor Lyse with respect to the importance of paste content were also in accordance with Professor Carlson's conclusions, contained in a remarkable paper, setting forth a theory of the chemistry and physics of concrete shrinkage. The theory maintains that the shrinkage of concrete is governed by the amount and quality of the gel, principally the calcium silicate gel; that the large attractive forces which hold moisture in the pores of the gel are effective in attracting the atoms of the gel closer together when the water evaporates, thus mechanically compressing the gel and reducing its volume; that aggregates placed in the cement paste remain constant in volume while the paste shrinks, placing the paste in a state of tension and the aggregate particles in a state of compression, except that thin films of paste between aggregate particles may be under compression; that these thin films undergo large plastic or elastic deformations, the size depending upon the number of air pockets or voids on the surface of the aggregates; that moisture is taken up by porous aggregates, contributing to paste shrinkage. So far, according to Professor Carlson's tests, the factors that are belived to have a major influence on concrete shrinkage are: (1) Amount and quality of gel in the hydrated cement, a factor governed by water content, cement fineness and composition, and time of moist curing; (2) amount of cement paste; (3) surface character of the aggregates as regards the ability to entrain air; (4) Depth of the concrete below an exposed surface; (5) size of concrete specimen; (6) plastic flow of cement paste; (7) humidity to which concrete is exposed; (8) direction of moisture movement; (9) size of aggregate, mainly as it affects water content, voids and number of surfaces of contact between the paste and the aggregate; (10) time of exposure to drying; and (11) porosity of aggregate.

Rigidity, gradation, shape, and chemical composition of aggregates have a minor influence on shrinkage, it is believed.

Prof. C. H. Scholer (Kansas State College) reported some long-time results on 6x12-in. concrete cylinders, studied to determine any variability in the modulus of elasticity. The tests, begun 4 years ago by P. M. Noble have been continued by L. H. Koenitzer at Kansas State College. Over 55,000 measurements have been taken. At the end of 4 years, the modulus of elasticity is about the same as at 14 days. Poisson's ratio on the other hand showed a rapid increase for the first 56 days, then a gradual decrease until at 4 years it was equal to or less than it had been at 14 days. Aggregates have an important influence on the elastic properties of concrete. As one example sand-gravel concrete specimens had a lower modulus of elasticity when wet than when dry while the opposite was true of coarse aggregate concrete.

Concrete committee actions

A new tentative specification for concrete irrigation pipe, 6 to 24 in. in diameter, was approved. Also revisions in the tentative specification for reinforced concrete culvert pipe were adopted; this pipe varies in diameter from 12 to 84 in.

The past year's work of the committee on concrete and concrete aggregates produced a number of specification revisions although none is of wide interest. New projects undertaken by the committee cover: (1) Effect of crusher dust in crushed stone on the quality of concrete; (2) method of sampling wet concrete; (3) method of measuring the volume of wet concrete; and (4) correlation study of modulus of rupture tests on concrete beams.

A tentative method of making compression tests of concrete using portions of beams broken in flexure was adopted, based upon work done at Kansas State College and by the Kansas state highway commission. A tentative method of determining voids in coarse aggregate identical with the existing method for fine aggregate was adopted; later, it is planned to combine the coarse and fine aggregate methods in a single specification. The methods of test for the soundness of fine and coarse aggregates by the use of sodium sulphate were revised to include provision for the use of magnesium sulphate.

The joint committee on concrete and reinforced concrete promised a substantial and probably complete report at the next annual meeting. The major part of the report is said to be finished now but the committee decided against partial publication.

Developments in timber

An important proposed specification change and two significant papers comprised the outstanding contributions of the session on timber. In addition, the tentative specifications for creosote and for creosote coal tar solution as used for timber preservatives were advanced to standard, and a revision in the tentative specifications for timber piles was adopted which combines comparative sizes of the three classes of piles in a single table, for ready reference.

The existing specifications for structural wood have proved too complicated to permit of their use in specifying and purchasing; the classification by grade names has presented particular difficulties in this respect. As a consequence a proposed revision was presented for trial use and discussion, in which values of extreme fiber stress in bending are substituted for grade names; a grade now known as "dense select" for example would be designated as "1,800 lb. *f*" grade. Complete tables are included for each grade covering slope of grain, permissible knot sizes, shakes, checks, splits and wane.

A paper on methods of testing fire-retardant treated wood by C. R. Brown (Bureau of Standards) compared the fire-tube and flame penetration tests as procedures for indicating some of the properties relating to the tendency of wood to support combustion and spread fire. Both treated and untreated specimens were used, varying in species, source and type of treatment. From the fire tube tests (in which a $\frac{3}{8}$x$\frac{3}{4}$x10-in. specimen hung vertically in a sheet metal tube is subjected to a bunsen burner flame applied 1-in. below the lower end for 4 min., with weight loss and temperature readings taken) it was determined that untreated and well-treated wood are readily distinguishable, thus, weight loss for well-treated wood ranged from 10 to 25 per cent with a 250 deg. C. maximum temperature, while for untreated wood it was 75 to 87 per cent with maximum temperature of 750 deg. C.

The flame penetration test consists in subjecting a 10-in. square specimen, supported horizontally, to a flame whose tip is 3 in. below the center of the specimen. A thermocouple on top measures temperatures, and the times for light to come through any crack, for flame penetration and for ignition are observed as well as the duration of flaming. These tests indicated that rate of weight loss is the best measure of difference between treated and untreated timber; representative test results were 6.9 to 9.9 gr. per min. for untreated and 1.6 to 2.1 gr. per min. for treated wood.

It was concluded that either the fire tube or flame penetration test gives a measure of effectiveness of treatment. The fire tube test gives a sharper distinction between degrees of treatment while the flame penetration test has the advantage of requiring no special equipment and shorter specimens; also fewer specimens are required in the flame penetration test since each is representative of a comparatively larger cross section of wood.

Physical properties of pine

Most studies of strength of timber have been concerned with average values for a species whereas knowledge

of variations of strength and other properties within a single species, also very important and usually more widely variable, has not often been sought. An investigation designed to correct this lack of knowledge was reported by A. W. Trust and E. E. Berkley (Washington University, St. Louis). By making allowances for differences in cell structure (caused by the age of the tree, its conditions of growth and the position of the cells in the cross section), in density and percentage of summerwood, mechanical properties may be judged more accurately, they conclude.

Material was taken from one log of loblolly pine, two of longleaf pine and one of shortleaf pine. Maximum strength, proportional limit and stiffness in compression and bending together with density, percentage of summerwood, rate of growth and moisture were determined for each of about 2000 specimens. In general, strength, elastic properties and density increased from the stump to the top of the log and from the pith outward to a maximum in the outer rings of young trees; in old trees maximum values occurred between the 80th and 100th rings beyond which they decreased toward the bark. No consistent relation was found between strength and rate of growth as measured by ring thickness. Specimens of the same density often varied 50 per cent and more in stiffness, supporting the contention that density alone is not a criterion of strength. Timber of greatest strength and elasticity per unit weight contained long straight fibers of concentric laminations and contained a minimum of resin ducts and wood rays.

Summerwood content, another common strength criterion, was found to be unreliable if a large number of irregular cells were present. For fixed moisture content, the modulus of elasticity varied more widely than did the strength. More careful observations, to detect defects in the clear wood of single timbers, are recommended.

Road materials and tests

New specification work in the field of road and paving materials did not compare in importance with some of the research investigations reported, particularly those dealing with asphalt cracking and with soil and aggregate studies. A new tentative specification for determining material in aggregates finer than the No. 200 sieve was, however, adopted with the hope that it could eventually replace two existing methods which have the same purpose but differ in technique. It substitutes a simple washing and weighing method for the present sedimentation methods whose refinements are not warranted by the purpose of the tests.

Asphalt at low temperatures

Although cracking of asphalt pavements in cold weather is a problem comparable in importance to instability of asphalt mixtures under normal or high temperatures, it is only recently that investigators have accorded it much attention. An interesting research program was reported by Prof. L. F. Rader (Polytechnic Institute of Brooklyn) in which small asphalt beams and briquets chilled to low temperatures by carbon dioxide were tested for modulus of rupture, modulus of elasticity and toughness. The behavior of chilled asphalt mixtures was found to be similar to more brittle materials having definite load-deflection curves, and it was concluded that cracks are due to excessive tensile stresses caused by contraction. Therefore, a high modulus of rupture is desirable, to minimize cracking; likewise, a low modulus of elasticity is desirable. High tensile strength of sheet asphalt mixtures at low temperatures is a direct function of degree of compaction. Although the tests indicated that source and method of refining of asphalts have little relation to cracking resistance, they also showed that mixtures containing the highest penetration asphalt and the highest percentage of asphalt consistent with necessary stability are most resistant to cracking at low temperatures.

Professor Rader's suggestion that low temperature physical tests may be used in designing mixtures for ordinary service was challenged by Roland Vokac (Barber Asphalt Co.) as being unsafe in the present state of knowledge. Mr. Vokac, at the same time, urged that asphalt materials be studied as are other engineering materials, with definite strengths, elastic limits, etc., instead of from an empirical standpoint only. He outlined studies of elasticity and toughness at temperate zone temperatures, using a Page impact machine. Curves obtained by plotting height of hammer drop against blows to failure at various temperatures approach vertical at high temperatures and horizontal at freezing temperatures. The slope is an "index of deformation" which varied from 0 to 1.4 for the tests made. Other tests using the compression testing machine developed for cement mortar cubes produced typical stress-strain diagrams—a straight line portion (in which the material is perfectly elastic) is followed by a yield point and a bulge to maximum load and finally another straight line sloping downward to the right. This latter slope has been called a "modulus of mobility." Typical results from these tests were modulus of elasticity, 15,600; ultimate strength, 590; modulus of mobility, 5620, and yield strength, 490 lb. per sq.in.

Further discussion on cracking was contributed by C. M. Baskin (Imperial Oil Co.) who told of studies of cracking in Canada. Most cracks occur in spring when the frost is coming out of the ground; they probably originate in movements of the subsoil. Mr. Baskin advised that any contemplated laboratory studies be preceded by careful field investigations which he feels will disclose many facts that are so obvious as not to require further research in the laboratory.

Soil studies

Further papers in the road session concerned a new investigation of stability of granular mixtures reported upon by D. S. Berry (Michigan highway department), a description of his penetration method of measuring soil resistance by Prof. W. S. Housel, University of Michigan, (*ENR*, Aug. 11, 1932 p. 161) and a report by D. O. Woolf and D. G. Runner of tests made at the Bureau of Standards, to compare the Los Angeles rattler with the Deval abrasion machine for determining the quality of coarse aggregates (*ENR*, March 7, 1935, p. 349).

Mr. Berry's report concerned an investigation being planned by the Michigan highway department, to measure the stability of mixtures used in flexible-type road construction. Apparatus has been developed to determine bearing capacity and shear resistance and a special vibration machine is being used to control the degree of compaction of the materials. The vibration machine is a modification of the one developed by the Bureau of Public Roads for vibrating concrete beams and is very useful in securing compactions greater than are possible with hand tamping. Additional and improved equipment is under development. So far results are being used largely to point the way to future research. Some of them are as follows: (1) Internal resistance or stability of granular materials depends primarily on the interlocking of the individual particles, in turn influenced by compaction, angularity and extent of gradation; (2) shearing resistance of a granular material is a function of normal pressure; (3) bearing capacity under surface load varies with the size of the loaded area and is controlled by boundary conditions; (4) resistance of granular materials to displacement is decreased by a deficiency in shear resistance on horizontal planes at depths less than the width of the loaded area.

A specification for asphalt plank has been prepared and is under consideration by the committee on road and paving materials.

Waterproofing and roofing

Some half dozen or more specifications sponsored by the committee on bituminous waterproofing and roofing materials were revised in minor particulars. A further report by the subcommittee on accelerated weathering tests of bituminous materials, in which use is made of a carbon arc lamp, presented data establishing the reliability of the test, on the basis of close duplication with outdoor results which have to be obtained in a much longer period of time. With a few more refinements,

the method will be recommended as a tentative standard.

Clay products

Some interesting developments were recorded in the field of clay products, particularly brick. Revised specifications for building brick made from clay or shale are believed to afford the consumer somewhat more protection regarding factors of weathering. New revisions of testing procedure for such factors as modulus of rupture, compressive strength and absorption of brick bring this work more in line with the usual practices followed. D. E. Parsons, chairman of the subcommittee on weathering and porosity of brick, submitted a review of methods for classifying brick with respect to durability. Of the several agents of weathering, frost action and crystallization of salts within the voids are chiefly responsible for the disintegration of clay brick, according to Mr. Parsons. Also, the resistance of the unit depends largely on the heat treatment during manufacture; well-burned brick is likely to be of satisfactory durability. A method of estimating durability that is particularly useful utilizes the ratio of 48-hr. cold water absorption to 5-hr. boiling water absorption. Brick are apt to be highly resistant to severe frost action if this C_aB_5 ratio is less than 0.80, if compressive strength exceeds 2500 lb. per sq.in. and if the absorption by 5-hr. boiling is less than 20 per cent. The subcommittee suggested that the maximum C_aB_5 ratio be limited to 0.85 and the minimum compressive strength to 2500 lb. per sq.in.

The C_aB_5 ratio is a measure of the degree of saturation obtained during the submergence in water. It affords, therefore, a measure of the proportion of the pore space, accessible to water, that is filled by simple soaking for a standard time, the remainder being available to relieve the pressure which tends to develop as the entrained water freezes. Comparisons indicate that the C_aB_5 ratio could be substituted for the C_aB_5 ratio without changing materially the values for bricks having ratios greater than 0.80. Obviously, this would decrease by one day the time required for a test.

The C B ratio has not been shown to be an effective measure of the resistance of brick to the crystallization of salts, although some investigators contend that it is significant in that connection.

Brick mortar tests

Since the strength and the integrity of the bond between the mortar and the brick are prime essentials in reinforced brick construction, the subject was given special study at the University of Wisconsin by Prof. M. O. Withey and Instructor K. F. Wendt. Tensile and compressive strengths, linear change measurements, absorption, freezing and thawing and autoclave tests, as well as workability ratings, were reported by Professor Withey for tests made on 1:3 and 1:4 portland-cement mortars rendered more plastic by additions of lime or pulverized clay. Approximately 82 mixes and 4000 test specimens were utilized.

Various other tests were made on the physical and mechanical properties of mortar and brick and on tensile and shear bond strength of assemblies of certain bricks and mortars. Among the significant conclusions were the following:

(1) Mortars of 1:4 proportion tempered with 25 to 33 per cent of hydrated lime or 20 to 25 per cent of very finely ground clay are sufficiently workable and strong for most reinforced brick masonry under moderate exposures. Where high strength is wanted or the exposure is severe, a 1:2½ mortar with 25 to 33 per cent of hydrate or a 1:3 mortar with 17 to 25 per cent of clay is tentatively recommended.

(2) Soaking the hydrated lime prior to mixing in nearly all cases rendered the mortar stronger.

(3) Mortars made with dolomitic hydrates were stronger than those made with the high-calcium hydrates.

(4) Mortars of the low-water ratio dolomitic hydrate were more resistant to freezing and thawing than the other lime-cement mortars tested.

(5) Dolomitic lime-cement mortars containing over 11 per cent of hydrate by weight of cement expanded unduly when continuously wet or when moist cured and tested in an autoclave.

(6) Under dry curing conditions, lime-cement mortars with the higher lime contents contract slightly more than the portland cement mortars.

(7) The clay-cement mortars were somewhat less workable, exhibited lower expansions under moist curing, but under air curing contracted somewhat more than the lime mortars.

(8) The use of calcium chloride to increase the early strength of a mortar is attended by a marked increase in contraction under air curing.

(9) The results indicate the desirability of ascertaining the properties of cement mortars containing mixtures of both lime and clay. The magnitude of the linear changes of the lime-cement and clay-cement mortars in certain curing conditions necessitate determinations on the durability of the bond of these mortars to brick.

Other masonry materials

The tentative specifications for clay sewer pipe, revised slightly, were adopted as standard. A complete revision of the standard definitions of terms relating to sewer pipe has also been prepared. Specifications for structural clay tile were carefully reviewed during the year, to compare them with the needs of consumers; with the result that it was concluded that there is no need for specifications covering any new types of units. However, since smooth tile usually is heavier than tile with scored faces, revisions in the specified weights for smooth tiles were proposed and adopted.

Plastic calking materials such as are used to seal joints between masonry and in door and window frames have been under investigation at the Bureau of Standards, to perfect test procedures and apparatus for determining the quality of such materials. Four types of tests have been developed, a strain test, to determine whether the material remains sufficiently plastic in a joint to accommodate itself to structural movement; a staining test, to determine whether the plastic discolors the masonry near the joint; a slump test, to determine whether the material becomes too soft in summer, and a copper corrosion test, to indicate the quality of oil in the plastic material. The value of the latter test is not definitely established and a large percentage of the samples passes it satisfactorily. F. O. Anderegg, consulting engineer, Pittsburgh, expressed the belief that plastic calking materials must be inspected every three years to detect any open joints. Where metal trim has been used on tall buildings, as for example, stainless steel and aluminum, he has noted an increase in the difficulty in obtaining tight, weatherproof joints, indicating a field for new study.

Prof. J. R. Shank (Ohio State University) outlined a series of wear tests for flooring materials in which cores cut from various sandstones, marbles, granites, slates, cement and ceramic products, were tested in a Dorry machine such as has been used in testing stone for roadbuilding purposes. Silica sand was used on the steel base of the machine as an abrasive, and wear coefficients for volume and depth of abrasion determined. Additional investigations are being made with a revamped Dorry apparatus in which a rubber instead of a steel base is used in one instance, and a leather base in another. In discussion, Professor Withey of Wisconsin stated that their experience in using the Dorry apparatus has been most satisfactory when core specimens as large as 2½ in. in diameter are used.

Prestressed ceramic members, such as have been used recently on some prefabricated houses, were described by F. O. Anderegg, consulting engineer, Pittsburgh. The members are made up of blocks strung on reinforcing rods, the assembly being made with the rods in vertical position. As each unit is strung over the rod, a layer of mortar is applied to its top. With the member assembled, bolts on the ends of the projecting reinforcing rods are tightened slightly, so that the mortar sets under pressure. Reinforcing rods are then stressed until under dead load the neutral axis is about at the center of the member. Houses have also been built of prestressed members made of poured calcium hydrosilicate.

Civil Engineers at Summer Meeting Discuss Regional Subjects

Los Angeles meeting gives main attention to engineering undertakings of Southern California and to subjects of special interest to engineers of the western states

CIVIL ENGINEERING works of the Los Angeles metropolitan area and general engineering studies with which the engineers of the West are most directly concerned made up the principal subjects considered at the technical sessions of the 65th annual convention of the American Society of Civil Engineers, held in Los Angeles July 3-7. About 500 members and guests were registered. According to custom, the board of direction met during the two days preceding the general meeting. Its action on subjects of special interest to the society was reported to the members at the opening session of the convention.

Outstanding issues before the board of direction were the place of the society in the profession and the economic status of individual members. Many elements of these issues were covered in the report of the board's special committee on aims and activities, and as that report was found to comprise broad possibilities and to involve the future of the society profoundly the board adopted the committee's recommendation that a larger committee be authorized to continue the study further and on even broader lines, taking up every phase of possible society activity. Both the board and the society at large are to be represented on this committee.

Attention was given to the terms of a proposed form of agreement with federal officials under which engineers would function in administrative and executive capacities on federal relief work projects, receiving pay on the basis of a fee proportional to the total salaries paid for technical assistants.

Announcement was made of gratifying results of previous board action in making representations to the PWA on behalf of two society members. These members had been listed among those with whom the PWA "would have no dealing," but after receiving the facts presented by the board the administrator rescinded the adverse listing. Seven cases relating to alleged unprofessional conduct were considered.

Pittsburgh was selected for the fall meeting, and decision as to whether there would be a spring meeting next year was deferred. Portland, Ore., was chosen for the summer meeting of 1936.

Society activities

Society activities and the development of local sections, student chapters and technical divisions were reviewed by Arthur S. Tuttle in his presidential address. Mr. Tuttle stated that in the early days of the society failure to recognize the needs of specialists and to provide them with an opportunity to get together and discuss their peculiar problems, as is now done in the technical divisions, resulted in the formation of new societies devoted to one special subject. The technical divisions now meet this need, Mr. Tuttle said. He holds that their expansion should be encouraged, yet he is firmly convinced that they should not be developed to the point of excluding general meetings of all members.

With regard to local section activities Mr. Tuttle favors building up the sections by assigning each member of the society to a local section. Also, he would integrate the local sections in states where there is more than one section so that they can act as a unit in state matters.

Grade of "Fellow" proposed

The proposed amendment to the constitution which would abolish the grade of associate member and establish the grade of "fellow" was explained at the business meeting by J. P. H. Perry (New York), who proposed a revision in the amendment as printed, changing the requirement for length of membership from ten years to five. This change met with general approval. However, on the fundamental point as to whether the amendment in its entirety is a desirable change, several questions were raised. J. C. Stevens (Portland) expressed the opinion that the proposed changes amounted to adopting names of new grades without defining them; he felt that under the proposed plan there would be loss of the distinction which now attaches to full membership; that the sacrifice would not have any worthy objective and that standardization with other founder societies would not in fact result from this change.

John P. Hogan, New York, pointed out that the committee which drafted the amendment had studied the question very carefully; had worked toward the objective of raising the estimate of the profession in the minds of the public and had developed a membership rating which should facilitate that. After general discussion from the floor it was voted that when the proposed amendment is sent out for letter ballot of the membership it is to be accompanied by statements both for and against.

Three resolutions, approved by the board of direction at its meeting, were adopted by the society at the business session substantially as drawn up by the board. Thus, the society:

(1) Approves the work done by the water resources section of the National Resources Board and of the water planning committee, and urges upon the administration the continuation and expansion of that work under the new National Resources Committee.

(2) Directs attention to the need for adequate maps in planning for the use and development of natural resources and urges those charged with the allotment of relief work funds to provide adequate means for continuing the work of the federal mapping agencies and for expansion of their programs as a means of providing employment for many engineers.

(3) Expresses strong opposition to the regulations recently issued by the administration requiring that relief funds be distributed on the basis of $1,140 per man per year and that 90 per cent of the labor be taken from relief rolls, and urges the adoption of new rules and regulations that will permit useful work to be done, thus carrying out the purposes of Congress as expressed in the emergency relief act of 1935.

Los Angeles area

The second general session was devoted to subjects relating to California, and more especially to the Los Angeles metropolitan district. A. L. Sonderegger (Los Angeles), set forth clearly the bearing of physiography on engineering developments in the region. In flood control, for example, Mr. Sonderegger stated that the lack of suitable dam sites with adequate foundations for masonry structures is a controlling element in determining the type of structures to be built. Also, he pointed out that in the past failure to recognize the controlling elements has been responsible for the failure of some flood control undertakings.

J. B. Lippincott and Charles T. Leeds discussed the general subject of engineering contributions to the development of California, citing some of the high lights such as the development of earth fill dams as a resultant of hydraulic mining activities; the evolution of light riveted pipe with slip joints as a natural consequence of early mining practice in hydraulic sluicing; solution of the water supply problem in the dry south coastal plain area by the evolution of deep well sinking practice and particularly by the design of a pump adapted to service under high heads.

R. F. Goudey (Los Angeles), frankly

and constructively outlined the lack of coordination and cooperation in several phases of regional development where there would be great advantage in uniting various agencies for the common good of the region. He stressed the need for coordination of governmental agencies in developing future services and outlined the advantage to the region as a whole of putting these services on a cooperative basis under unified control.

Prof. Franklin Thomas (Pasadena), pointed out that some of the future requirements of the region, such as its water supply, are being provided for while others such as rapid transit have not yet been worked out in detail.

Weather reports

Progress in the efforts that the society through its Irrigation Division has made in obtaining a better geographical distribution of Weather Bureau stations was reported to the division at its opening session by J. B. Lippincott. The movement has been greatly aided in recent months by the National Resources Board committee on standards and specifications for hydrologic data, of which Donald M. Baker (Los Angeles), was chairman. Mr. Lippincott said that the whole matter of improving Weather Bureau data and records has been referred to the Science Advisory Board and that he had been asked to sit on the committee to report on meteorological records.

Water conservation

H. F. Blaney, secretary of the water conservation committee of the Irrigation Division, reported on the work of that committee. Since its organization it has directed its attention to water conservation in California, especially to the problems of southern California where water conservation is of vital importance.

The committee emphasized the need for a comprehensive and continuing study of evaporation, also for a study of the runoff from small areas. Such a study, it stated, should be undertaken by the federal government. The committee reported on the relation of loss of ground cover to runoff in the southern California area and pointed out that water spreading cannot be considered a means of flood control.

Runoff of western rivers

Variation in the runoff of western rivers was the subject of three papers before the Irrigation Division, by S. T. Harding (Univ. of Calif.), Lynn Crandall (Idaho Falls), and Robert Follansbee (Denver).

Prof. Harding based his paper chiefly upon studies of variations in the levels of large lakes in California, where runoff records go back 40 years and fragmentary information gives indication of runoff conditions for 100 years. By a study of tree growths within the lake margins now subject to overflow Prof. Harding has come to the conclusion that the inflow to the lakes during a considerable part of the period of record was higher than for many years during the period immediately preceding. In that period trees of considerable size whose age can be determined grew within areas now submerged.

The practical application of these conclusions indicates that storage must be provided to make up for accumulated annual deficiencies in any plan for water use based on known records. If storage is not available the excess in periods of high flow must be wasted or uses must be adopted in which the demand can be varied from year to year. This is possible with certain types of irrigated farming and with hydro-electric plants supplemented with stand-by steam.

Mr. Crandall dealt with the Columbia, Snake, and other Pacific Northwest rivers where some records go back to 1878. Present records, Mr. Crandall stated, may not safely be taken as comparable with earlier records of runoff in the Columbia River basin, for moisture now transpired from large irrigated areas may be reprecipitated within the basin. Also, runoff conditions in one river of the basin cannot be taken as indicative of a corresponding increase or decrease in flow in another river in the basin, for wide variations in runoff of different streams occur in the same year.

As to water use, Mr. Crandall said that it is difficult to keep small irrigation projects from being developed to the point of using all the available water in years of high runoff, but that such a condition should not be permitted to develop on large projects.

Mr. Follansbee's paper reported that Wyoming and Colorado records show no period of deficiency like that beginning in 1923. A similar condition is revealed by records of the Rio Grande for a like period, but there the records are of longer duration and do show a period of deficiency similar to that of 1923 at an earlier date. Correlation of known records with tree ring growths again shows a fairly close relationship and thus justifies extending the runoff curve back some 400 years.

In response to a question by J. B. Lippincott as to whether these records are applicable to the entire continent, Prof. Harding said probably not, as the known fluctuations of relatively close streams do not coincide in many instances.

Waterways

The program of the Waterways Division meeting was altered somewhat to provide an opportunity for Oliver J. Todd, chief engineer of the China International Relief Commission, to tell of transportation conditions on the Yellow River in China, also of flood control works, river regulation and channel maintenance.

Following Mr. Todd's talk, the development of Los Angeles and Long Beach harbors was discussed by Gen. C. FitzGerald, C. T. Leeds, and J. W. Blackman. Mr. FitzGerald said that since 1909 the city had raised $29,000,000 in bonds and the federal government had spent $13,000,000 on this almost entirely man-made harbor, and that in the peak year 8,633 vessels had used the port facilities. While petroleum products still make up a major part of the traffic, general merchandise traffic is increasing.

In discussion, Col. Leeds pointed out the difficulties growing out of the divided control of the port facilities by Los Angeles and Long Beach and urged closer cooperation between the harbor commissions. Mr. Blackman outlined the advantages that have accrued to Long Beach due to the fact that much of the harbor area was privately owned and could be sold to industries unwilling to lease publicly owned land for which future rentals could not be definitely determined. Mr. Blackman also reviewed the notable experiments in the use of asphalt-impregnated piles in Long Beach harbor.

The effect on water use, on salt water intrusion and on navigation of the once-proposed salt water barrier below the confluence of the Sacramento and San Joaquin rivers was the subject of an extended paper before the Waterways Division by Edward Hyatt, state engineer of California. This paper reviewed the exhaustive studies of the project and pointed out that the capital cost of providing a supplemental water supply to offset the effect of salt water intrusion would be half that of the proposed barrier. It showed also that even with the barrier the intrusion could not be checked completely, thus requiring an additional water supply.

A. Kempkey (San Francisco), stated that the conditions created by such a barrier might conceivably be worse than present conditions. Prof. M. P. O'Brien (Berkeley), said that the barrier could be ruled out on purely technical grounds, that studies conducted at the University of California indicated clearly that salt intrusion through the navigation locks could not be prevented.

Traffic regulation

The subject "Observance of Traffic Control Devices and Regulations" provided incentive for discussion throughout the Highway Division session, although the only discussion prepared in advance was that presented by E. B. Lefferts (Los Angeles). Several speakers stressed the bad features of fixed speed limits; legal speeds often are unsafe and illegal speeds often are safe. The multiplicity of speed limits makes for more confusion now that interstate travel is increasing with better automobiles and better roads.

Oregon's accident record is good, said Orrin E. Stanley (Portland); the fixed

speed limit has been abandoned in Oregon, and state highways are designed for speeds of 80 m.p.h. or more where conditions permit (*ENR*, May 23, 1934, p. 752).

Col. W. W. Crosby (San Diego), made a plea for wider highways to provide "elbow room" for future expansion and to lessen serious results from encroachment of the parasites that develop along well-traveled routes.

Traffic engineering is a new branch of the profession, said Mr. Lefferts, which must deal with a constantly varying element in traffic problems—the human equation. Something more than laws must be used to build up safer driving habits; first, traffic regulations must be made right, and then a campaign for better observation must be undertaken. An example of what can be accomplished by educational campaigns appears in the decrease in the accident rate for commercial vehicles in recent years during which such campaigns have been made by firms employing drivers. Possessing a driver's license must be regarded as more of a privilege; licensing the immature and the aged is to be condemned, and suspension of the driving privilege must follow repeated disregard of traffic rules.

Los Angeles has a Saturday morning traffic school which juvenile traffic-law violators are sentenced to attend. After attendance for a stated number of times a written examination must be passed with a grade of 75 per cent before the violator can get clearance from his court sentence. In the past four years 3,800 boys and girls have attended this school.

Agreement as to the dangers of three-lane highways and the questionable right-of-way in the middle lane, was followed by a plea for substituting, in new construction, a four-lane project on which the two outer lanes would be heavily paved for main traffic lanes and the two inner lanes would be lightly paved (assuming strictly limited funds), to serve passing traffic only until funds for full pavement became available.

Next week, the concluding report of the Los Angeles meeting will cover flume design, aqueduct construction, state planning, water supply and sewage disposal.

Letters to the Editor

Headache Specifications

Sir—We have just recently collided with a specification that not only has the "let me out" clause that reads "Furnish any additional steel that is required whether shown or not at no additional cost" but a "let me out more" clause as follows: "The steel contractor shall guarantee the owner that columns 4 and 5 will carry the marquee." The only information given on the marquee is that "The contractor shall allow $3,000, and the type of marquee will be determined at a later date."

We hope at a future date that the Bureau of Research and the A.I.S.C. will get together and establish a formula for these cases reading something like this:

$$\text{Cost of column} = \frac{\text{cost of marquee}}{L}$$

in which L may equal *length* of marquee, *lever* arm of marquee, *load* on marquee and *length of time* to select the type of marquee.

Allentown, Pa., May 2, 1935. W. O. BARKLEY, Engineer.

Preservative Treatment for Douglas Fir Piling

Sir—Careful reading of recently published specifications on preservative treatment for piling has lead to some confusion among engineers who are interested in specifying and using treated timbers. Even the very excellent paper by Dr. Herman von Schrenk, consulting timber engineer of St. Louis, before the American Wood Preservers' Association (abstracted in *ENR*, March 15, 1935, p. 383) is not in accord with Pacific Coast practice.

Dr. von Schrenk's statement regarding the greatest possible protection being obtained with the thickest ring of treated sapwood would be more in line with the best practice of protection against marine borers, I believe, if this statement included the stipulation that the greatest concentration of creosote should be obtained in this penetrated portion.

Specifications for the reconstruction work in Boston harbor required a minimum of 3 in. of sapwood, thorough air seasoning of piling and (being in northern waters) 20 lb. of creosote per cu.ft. Specifications of this type automatically exclude the use of creosoted Douglas fir, a material that has been used on the Pacific Coast with outstanding success for many years. Two notable examples which have excellent service records are the Oakland Long Wharf of the Southern Pacific Railroad in San Francisco Bay (*ENR*, Aug. 21, 1919, p. 378) and the Santa Monica Long Wharf built by the Southern Pacific Railroad in 1891 and 1892 (*Wood Preservers News*, December, 1919). In the Oakland Long Wharf the majority of the piles were artificially seasoned and were given an average absorption of not over 10 lb. per cu.ft. After giving a service of 18 to 29 years, 71 per cent were found sound and fit for redriving. Piles in the Santa Monica Long Wharf, treated with an average retention of 14.17 lb. per cu.ft., were in service for more than 38 years.

Careful examination of many of these creosoted Douglas fir piles removed from the Oakland Long Wharf after 29 years of service showed that this long life was attained in many cases with a penetration of only ½ in. of creosote.

For marine structures on the Pacific Coast where marine borers are very active it has been the practice for a number of years to require a minimum of 12 lb. of creosote per cu.ft. and a minimum penetration of ¾ in. Having inspected many thousand creosoted Douglas fir piles after treatment and a considerable number of treated piles in existing structures, it is my opinion that these piles are adequately protected against the attack of marine borers when treated so that the sapwood has a thorough penetration of creosote with a maximum concentration. Douglas fir piling is treated successfully with minimum absorptions of 16 lb. of creosote per cu.ft., giving a minimum penetration of 1 in.; and 20 lb. per cu.ft., giving a minimum penetration of 1¼ in.

R. H. RAWSON, Consulting Timber Engineer.

Portland, Ore., May 25, 1935.

Laminated Timber Arches

SIR—In your issue of April 11, 1924, p. 525, there was published an article "New Building Demonstrates Modern Wood Construction." The method of using arches, built up of glued laminations, is well known in Europe under the name of "System Hetzer." It happened that some years ago, I was chief construction engineer for the patent owners for Switzerland, and I am in possession of a complete list including photographs of over 200 constructions built in Switzerland in accordance with this system. Some of the constructions had been built as far back as 1908, and quite a few arches have over 100 ft. span. One of the best known structures was the main hall of the federal exposition in 1914 in Bern.

The system is characterized by its beautiful lines and, due to the possibility of varying the cross-sections of the members in accordance with the bending-moment diagrams, the higher labor cost is in most cases offset by the saving of lumber.

Knowing this system thoroughly, not only as applied to arches but also to beams and cantilevers, I am inclined to predict a big future for it as soon as some of the larger construction concerns give it the right start.

New York, N. Y., May 5, 1935. ERNEST H. SCHAUB, Structural Engineer.

ENGINEERING NEWS-RECORD

Volume 115, No. 2

Copyright 1935 by McGraw-Hill Publishing Company, Inc.

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, N. A. Bowers, W. G. Bowman, W. W. DeBerard, C. S. Hill, H. W. Richardson.

Editorial and Publishing Offices at 330 West 42d Street, New York

July 11, 1935

Common Sense About Employment

IT IS TIME to call a halt on schemes for spreading employment when the methods by which they are applied do more harm than good. This truth should be obvious; yet public officials in their zeal to make an employment record often ignore the harmful effect of what they do. An excellent example presents itself in a large public construction project, which, the city officials insisted, should be built under a 90-day labor rotation plan. This ruling resulted in serious loss of efficiency on the job. It has been the cause of delay, increased cost and risk, and in addition has exerted a demoralizing influence on the working organization. It appears that the plan is bringing no real benefit to labor. Men must be transported a long distance to the job, and the normal disadvantages of such a condition are aggravated by the fact that usually two or three men must be tried out before the right man is obtained for the job. Extra clothing and other equipment that the men require for the job are of little use to them when they return to town. The safety risk has been somewhat reduced by extending the 90-day limit to 180 days for labor grades involving special skill and training. But, on the whole, the disadvantages of the plan remain. Altogether, the result shows how a construction job can be hampered by unwise attempts to spread work.

Far-Reaching Benefits

WHAT KIND OF WORK-SPREADING really counts may be gathered from figures compiled by the Interior Department. They show how widely the construction cost of Boulder Dam is being diffused over the country and through the ranks of industrial workers in many fields. Out of the $108,800,000 total expenditure to build and complete the undertaking, an incomplete list of purchases shows that more than half ($62,500,000) will have been spent for materials and their transportation—cement, steel, machinery, pipe, powerhouse equipment, and a long list of supply items from tires and gasoline to rope, dynamite, paint brushes and tin hats. It needs no argument to show that these materials purchases, distributed over the whole length and breadth of the Union, were a more effective means of increasing employment and restarting the flow of normal activity in industry and business than a similar expenditure disbursed wholly in wages at the job site. Lest it be thought that this valuable effect was obtained at excessive cost, note should be made of the department's figures on total employment and cost per man-year. A rather conservative computation of direct employment both on and off the site indicates that the expenditure up to date, about $81,452,000, has produced nearly 43,000 man-years of employment, which means that one man-year of work resulted from each $1900 expended. This figure is low, but it would be much lower were secondary employment taken into account; and it should be remembered that the secondary or multiplying effect of expenditures through industry is greater than that of job-wage expenditures. In brief, the record well illustrates the constructive effect of useful projects carried out by normal processes.

What Is Portland Cement?

THE DECISION of the cement committee of the American Society for Testing Materials to examine the present-day value of the definition for portland cement as fixed in the standard specification should prove salutary. That the definition has existed for two decades without change is reason enough for a searching analysis of its present fitness; it has been criticised more than once on the ground that it is so rigid as to discourage attempts to improve cement quality. Under these conditions the cement committee displayed a commendably progressive attitude in approving the study of the present specification. It is to be noted that the philosophy which guided those who formulated the present specification was that the user, not often a chemist and seldom in a position to judge the merits of ingredients or methods of manufacture, needs to be protected, by a fairly rigid specification, against adulteration, dilution or harmful additions in the cement that he purchases. By and large the need for such protection still remains and will always exist. On the other hand, attempts to improve the product by new methods or materials should not be blocked by a definition so rigid as to obstruct progress.

Bored Cylinder Foundations

SUCCESSFUL APPLICATION of the principle of boring large caisson cylinders to their foundation level with their own structure operating as boring tool makes an important addition to the methods available for underground construction. Like the large-diameter churn-drilling used in constructing deep pier footings for the New Jersey shaft of the Holland tunnel (*ENR*, Feb. 8, 1923, p. 242) and the auger-boring of deep pier holes for the Detroit post office (*ENR*, July 28, 1932, p. 105), the present operations for the foundation of the new Federal Building in New York constitute a radical innovation and have made a working success on first trial. Foundation processes in the main are of slow and gradual evolution; only rarely does one become a full-fledged reality on first application as in these instances. The novel operation now described has therefore all the characteristics and inspiration of pioneering procedure. It called for unusual faith and courage, and a will to wrestle with unforeseen difficulties. Like all pioneering, too, it probably did not result in the ultimate finished form. Boring, or sawing, mixed ground is too new a problem to permit one to believe that there will not be further improvement in cutting-edge details, in machine and manipulation and in the certainty of getting down to final footing level through all obstructions. But with this large-scale application to its credit, the cylinder-boring process already claims rank with long-established methods and adds a valuable resource to the constructor's foundation-building equipment.

New Test for Sand Moisture

DETERMINATION of the moisture content of sand in the mixer bin by measuring its electrical resistivity is a promising advance in the field control of concrete mixtures. Its use at the Alton locks as described on a preceding page demonstrates the fundamental soundness of the method, while leaving a number of determinations

still to be certified and brought under control. The practical value of a quick determination of sand moisture needs only brief argument. Sand in bulk, as it comes to heavy concrete construction, is rarely of constant moisture content. Often the variation is so great as virtually to negative water-cement-ratio control, because with the usual wet-and-dry-weight method of moisture determination the knowledge of change comes too late; the results apply to concrete that has already gone into the structure. By the electrical resistivity method the water content is known nearly as soon as the sand enters the mixer bin, and changing the volume of added water is the task of a moment. Concrete engineers will do well to watch the further application of the method.

A New Start

BY THE LETTER of its terms the President's announcement of last week on the relief-works program does little more than draw a line between the respective functions of the new Works Progress Administration and the Public Works Administration. In reality, however, it does something vastly more important. It initiates a retreat from the long-threatening CWA movement, from the position that relief works have no relation to the progress of recovery.

Thus the announcement marks a new start in administering the four-billion-dollar program. While its full implications remain in doubt because of lacking detail, it is clear that sounder views are prevailing at Washington and that one of the basic purposes of the Emergency Relief Appropriation Act, "to increase employment by providing for useful projects," is tardily receiving recognition.

A definite place is made for works of permanent value. The application of normal contract and employment procedure is sanctioned, and hundreds of thousands of idle workers can be returned to real jobs rather than to an employment dole. A substantial program of useful construction now becomes possible; highway and grade-crossing work can be planned purposefully, and state, city and federal projects of permanently useful kinds can be carried out without unworkable restrictions on cost in proportion to direct job labor. This is a great and welcome promise of improvement; the unfortunate thing is that it comes six months late.

It is important, of course, that the promise be converted into reality. Unremitting effort can help to make sure that useful normal construction will maintain its place, and that the gigantic relief task does not submerge essential objectives. Perhaps in time the vital importance of secondary employment, the real recovery reliance, will find appreciation at Washington. But quite as much remains to be done back home.

For those outside the circle of the federal administrators, the fundamental reorientation of the program emphasizes certain obligations already pointed out. Increased unemployment over last year, shown by current records, makes restoration of normal employment more than ever important as the only course to ending of relief. Local authorities must measure their responsibility in the light of this fact.

That they have serious work to do in planning a sufficient number of work-relief projects and in seeing that these do not compete and interfere with normal activity needs no restatement. Greater responsibility, however, lies in the field of normal construction projects. It is essential that these be planned and prosecuted rapidly enough so that they may be sure of a place in the program. These projects are to be the means of restoring normal employment and promoting lasting recovery; whatever local contribution or assumption of debt is necessary to carry them through will be a profitable investment. Engineers and construction men who can bring these truths to recognition are in a position to render an important public service.

The Tailor-Made House

THE prefabricated house is on the upswing of another cycle. For over a decade the idea that the success of the motor industry with mass production can be duplicated in the house field has alternately enchanted and disappointed large numbers of individuals and not a few established companies. But in spite of the expenditure of countless hours of mental energy and of thousands of research dollars without success, the fascination of the idea of a prefabricated house remains.

The current phase in the development of a factory-produced house is worthy of note in that it involves an apparent effort to overcome some of the obstacles that thwarted previous attempts. All present schemes are not in agreement on the type of approach, but taken together they indicate new thinking. Most important is the realization that a prefabricated house, even granted superiority, will not sell unless it can offer price competition with conventional houses.

Many early schemes were advanced solely to promote the sales of a particular material. Much of the new thinking is predicated on the integration of various materials into a product that is complete and immediately usable. This new philosophy is accompanied by a shift in emphasis from structural materials to mechanical equipment. The early houses developed from the shell inward, while current efforts seem to concentrate on equipment and livability first.

Summed up, the changes in method of attack on the prefabricated-house idea embrace more of the success criteria of the motor industry than ever before—namely, low price, emphasis on the completed product and mechanical excellence. Obstacles still remain, however.

Established materials dealers are hard to wean from raw materials, although doors and windows have given them a taste of prefabrication. Building-trades labor is actively hostile. Architects are somewhat undecided between support and opposition—although they have never enjoyed much of the business that the prefabricated-house companies are courting. There is also the psychological factor represented by the prospective purchaser. He is not yet convinced that factory-made houses are homes. He is adamant in his wish for a house distinctively different from his neighbor's.

The fact remains that the prefabricated house is making progress. Pioneering so far has been stern and unfruitful, but there are always the success of mass-produced motor cars and the inefficiency of conventional building methods to keep the vision of ultimate success alive. Sometime, someone is going to offer a prefabricated house of outstanding efficiency, of extreme livability, of pleasing appearance and of low cost *at the same time* that a large number of people decide that a house made in a factory can be a home. When such a coincidence occurs, the rehousing of the nation on a modern economical basis should speedily become a fact.

CURRENT NEWS

President Divides Relief Works Between PWA and WPA at $25,000 Line

Washington Correspondence

PRESIDENT ROOSEVELT'S intervention has given some semblance of order to the relief works program. Although there is no indication yet of any intention to undertake any considerable volume of work in the near future, local authorities now know at least where to go with their project proposals as a result of the statement issued from the White House over the signature of Administrators Hopkins and Ickes, under which the Works Progress Administration will have charge of all projects costing, complete, up to and including $25,000. All projects over that figure will be handled by PWA except parks, playgrounds, farm-to-market roads and similar dirt moving jobs involving little actual construction. These form an independent category that, regardless of cost, will be financed and supervised by WPA. Mr. Hopkins will also have charge of white collar activities.

A 45 per cent grant is available on all PWA projects, and the remainder may be borrowed from PWA at 4 per cent if the sponsor is unable to obtain the loan elsewhere on more favorable terms. Sponsors of WPA projects will be called upon to contribute to the full extent of their ability, and priority will be given to project applications on this basis. Cities which undertake one or more PWA projects, however, will not be called upon to contribute as much for WPA work as they might have to otherwise.

There is some feeling in the Hopkins organization that defining the limit of WPA's jurisdiction at $25,000 reflects on the character of its program. They believe that WPA will build projects that are just as worthy of the name "public works" as anything that PWA erects. The division at $25,000 was suggested by PWA's past experience. Its docket shows that 905 projects which individually cost less than that figure totaled only $12,600,000 or 1.2 per cent of $1,069,000,000, which is the total cost of the 4,042 non-federal projects which PWA has undertaken in the past two years.

Types of projects for PWA

Restricting WPA to "small works" and "non-construction" items provides a clear right-of-way for public works, although it does not furnish an index of the comparative volume of work that will be done by the rival organizations. Applications for all construction projects, where the aggregate cost upon completion is estimated to exceed $25,000, should be submitted to the state directors of PWA. Examples of such projects are: airport buildings, armories, almshouses, auditoriums, bulkheads, canals, docks, dormitories, schools and university buildings, electric heat, light and power plants and distribution systems, gas plants and distribution systems, jetties, piers, wharfs, highways, bridges, tunnels, subways, viaducts, hospitals, dispensaries, sanitariums, markets, warehouses, city and town halls, courthouses, fire and police stations, jails, libraries, sanitary sewer systems, drainage improvements, garbage and rubbish disposal plants, public buildings, sewage disposal plants, storm sewer systems, terminals, water supply and distribution systems, filtration plants, and other similar projects.

Applications rejected by PWA should be submitted immediately to WPA. The volume of applications to PWA is increasing and PWA is pushing them on to the Division of Applications without delay. Allotments of $5,110,689 for non-federal projects, July 8, raise the total so far approved to $26,893,017. This figure represents only the 45 per cent grant, as loans made by PWA will be covered out of its revolving fund, replenished from time to time by the sale of securities purchased in financing previous non-federal projects. This portfolio totals about $200,000,000.

President urges speed

Heavy emphasis was put on continuing the construction of public works by President Roosevelt in greeting PWA state directors in conference in Washington this week to speed up this phase of relief works program. Volume will depend on the cooperation received from states and cities.

"The need of permanent work all over the United States is not yet ended," said the President. He explained that although expenditure of federal funds cannot exceed an average of $1,140 per man employed, local governments can get this work done by adding 55 per cent to the 45 per cent grant. The President told the state directors that it is up to them to induce local public bodies to put up their share.

"With the federal grant of 45 per cent of the total cost and money to be had from the PWA revolving fund at 4 per cent and in the bond markets, at even low rates for good security, there is no reason why there should not be a large volume of useful construction under this program," the President declared. "We want the work done and we want it done now. We don't want it to run over into 1937 and 1938. This money was given to us by Congress to spend during the fiscal year."

First WPA allotments

WPA state administrators have mapped work programs for Indiana, Georgia, Alabama, New York City and Washington, D. C., that will cost approximately $130,000,000, of which the federal government will contribute $127,000,000. These initial schedules will be followed by others for the same areas and for other states and

(Continued on p. 67)

PWA Housing Rules Liberalize Loans For Slum Clearance Projects

NEW REGULATIONS, providing a more liberal basis for financing slum clearance and low-rent housing projects, have been set up by the Housing Division of the PWA.

Under the new rules an outright grant of 45 per cent of the cost of the project will be made. The remaining 55 per cent will be a loan to be amortized by rents. Interest on this loan is not to exceed 3 per cent and the loan is to be retired in 60 years. Land cost will not be amortized but a 3 per cent annual land rent item will be carried by each project. Old regulations provided for a 30 per cent grant, 45-year amortization of property as well as building costs and 3 per cent interest on the loan.

The new terms, which are expected to reduce rents, will apply to 74 housing projects now under consideration in more than 60 cities. Contracts for construction of five of these have already been let and land acquisition is under way in 40 cities. Six of the seven limited dividend housing projects are occupied and the other is under construction.

Bids for the Outhwaite development, Cleveland, are being invited. The project, for which $3,084,000 has been allotted, is to replace 18 acres of slums with row-houses and apartments. Regulations under which the project will be conducted provide that 90 per cent of the workers shall be taken from relief rolls and that prevailing wages shall be paid. Purchases of cement and lighting fixtures for the development are to be made by the procurement division of the Treasury Department. Bids on this project will be opened Aug. 12.

Bids will also be opened August 15 on the West Side project in Cleveland for which $3,000,000 was allotted. PWA now is closing options on an 8-acre site in Atlantic City, N. J., and bids for demolition of present buildings will be advertised soon.

Work Begun on Staff Quarters For Passamaquoddy Project

A blast of dynamite, on July 4, signalized the beginning of work on the Passamaquoddy tidal power plant. With the allotment of enough of the Passamaquoddy fund for a year's work Major Philip B. Fleming has established headquarters at Eastport, Me. The unit in the Washington office of the Corps of Engineers which has been working on the plans for this project also has been transferred to Eastport. Work will start at once on an office building and the necessary housing for the staff, for which ground was broken by the dynamiting. So as to provide em-

ployment at the earliest possible date work will be begun in the near future on several small rockfill dams which will close the connections between Cobscook Bay and the sea. Quarries will be opened to obtain the necessary rock. Provision will also be made for securing all the necessary rock for the large dam. One of the first features of the project to be undertaken will be the construction of the bridge connecting Eastport with the mainland over the head race of the power house. Clearing and drilling in the Haycock reservoir also will be done this summer along with a detailed survey of the reservoir area and the drilling of the dam sites. Design of the bridge has been placed in the hands of Sverdrup & Parcel, consulting engineers, St. Louis.

Large Allotments Made to CCC And Resettlement Administration

Among the larger allotments approved during the first week of July was $97,500,000 to the Civilian Conservation Corps for maintenance and expansion during the first quarter of the 1936 fiscal year. This brings the total allotment to the CCC for continuance of its work to $319,234,000. The new allotment is to be used for maintaining the CCC at its new strength of about 650,000 men. Of the $319,234,000 already allotted about $160,000,000 has been obligated or is to be obligated for supplies, materials, and equipment. Among the major items purchased are $50,000,000 for clothing and $38,000,000 for automotive equipment.

The Rural Resettlement Administration has been allotted the sum of $91,000,000 with which to set up the organization and commence the program of rural rehabilitation and relief in stricken agricultural areas. The original recommendation of $100,000,000 has been reduced by $9,000,000, which went to the FERA for rehabilitation work up to July 1, at which time the Resettlement Administration began its operations. The Housing Division of the Public Works Administration was allotted $67,985,000 for low-cost housing and slum clearance projects to be carried on under the new liberalized regulations. For control of insect pests the Department of Agriculture was granted $110,000,000.

Legal Difficulties Cleared For New Orleans Market

Legal difficulties serving to obstruct the reconstruction of the old French Market in New Orleans, La., which will involve the setting back of the Mississippi River levee, the moving of railroad tracks and the rebuilding of steamship wharves were cleared by a decision of the Louisiana supreme court holding that the Orleans Levee Board may deliver bonds to the city of New Orleans in extinguishment of its responsibility in connection with the project. The project, exclusive of the wharf reconstruction, will involve the expenditure of about $650,000.

In carrying out the project, which will not only allow necessary enlargement of existing facilities, but will also prevent caving of the river bank, property owners in the district formed a corporation which will perform the requisite steps.

Heavy Rains in Western New York State Cause Worst Flood in Seventy Years

A FLOOD which reports characterize as the worst since 1865 swept over northern and western New York State July 7 and 8, inundating more than 40 cities and villages and doing damage estimated at $10,000,000. The actual extent of the damage could not be determined at the time of going to press as municipal and state engineers, as well as railroad engineers, were still engaged in making hasty repairs and doing relief work. Government meteorologists reported that during the cloudburst, which was responsible for 45 known deaths, as much as 9 in. of rain fell in several localities in as short a time as 15 hr. Glens Falls, N. Y., reported a rainfall of 10.35 in. Some 25,000 TERA workers and 1,500 CCC men have been transferred to the flood area. TERA has advised cities that it will repay 100 per cent of all rehabilitation costs.

Flood conditions which hit most of the state were concentrated in counties just north of the Pennsylvania state line. The storm traveled across the state in a northeasterly direction and entered northern New England, where reports also indicate heavy damage. In the southern tier of New York counties, public utility services were disrupted and many cities faced serious water shortage from damaged mains. Fires at Binghamton and Hornell caused extensive damage because water pressure failed. Railroad service and highway travel were seriously impeded by washed out tracks and bridges. It has been estimated by the highway department that 100 bridges in the highway system have been partially or totally destroyed. In the Binghamton district one 150-ft. span and one 100-ft. span were destroyed.

At Hornell, the water during the height of the storm was 7 ft. deep in the business sections of the city and reached a depth of 14 ft. in North Hornell. Five bridges were washed out and all highways to the west of the city are cut off. Railroad service is at a standstill because of track washouts and debris.

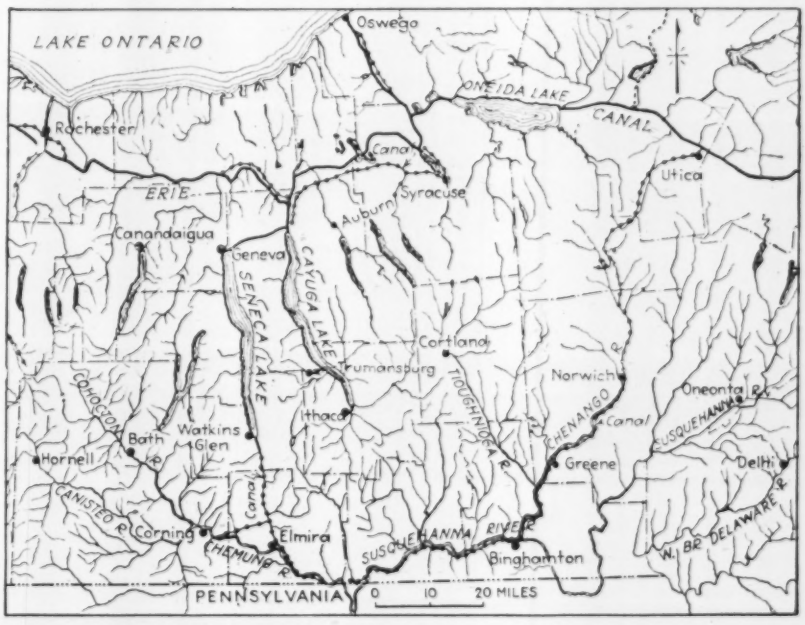
At Binghamton several houses were washed away by the flood and buildings in the business center were seriously undermined. Part of the city was without electric light service. All bridges over the Chenango River, except the Memorial Bridge, were closed.

In Delhi, where an 8.2-in. rainfall was reported, the village waterworks was demolished. Severe washouts occurred on the Delhi branch of the Ontario and Western R.R., and the subgrade of an 8-mi. highway being constructed to Bloomville was gullied to a depth of 9 ft. for most of the distance.

Ithaca threatened by Lake

Extensive damage was reported in Ithaca, where the section of the city near Lake Cayuga was flooded by several feet of water. Cayuga Lake rose 4½ ft. and efforts were made to move water out through the canal, Clyde River and Oswego River to Lake Ontario. Harry W. Eustance, city engineer of Ithaca, reported to *ENR* by wire that "damage to streets, sewers and athletic fields will run between $50,000 and $100,000. Worst street damage was on West Hill where pavements were torn up and undermined, and 1,000 ft. of sewer was taken out. Probably 1,500 cellars are flooded in the downtown lowland area and some are flooded in the business district. Only one bridge was weakened, the Lake St. span over Fall Creek having had its abutments partly undermined. Cascadilla Creek, between dike walls, is filled with gravel to within 2 ft. clearance of bridges. The weather bureau at Cornell University reported a rainfall Sunday totaling nearly 9 in. The maximum intensity was 0.30 in. in 5 min. An intensity of slightly more than 1 in. an hour was recorded for 3 hr."

(Continued on p. 66)



AREA OF NEW YORK STATE in which flood damage is heaviest includes the Finger Lakes region and the tier of counties just north of the Pennsylvania line.

New Water Supply Celebrated in Springfield, Ill.

Beginning July 12, Springfield, Ill., will celebrate for 2½ days, its dedication of Lake Springfield and appurtenant structures, including a dam and a bridge, which will insure the capital city an ample water supply and incidentally one of the largest bodies of water in the state available for recreation purposes. Some of the events involved in this celebration aside from the dedication of the spillway at Spaulding Dam and of the Vachel Lindsay Memorial Bridge are as follows: A motorcade, a picnic, a band concert at the new beach, massed choruses, boy and girl scout exhibitions, pageantry, and a field day of sports.

Water in Boulder Lake Rises To Base of Intake Towers

The water behind Boulder Dam has now reached El. 895, touching the base of the four intake towers through which it will flow to the power houses. The lake, which will eventually become one of the largest artificial bodies of water, is now 75 miles long and 255 ft. deep at the dam.

New York Flood Worst in Seventy Years

(Continued from p. 65)

More than a dozen buildings in the business section of Trumansburg were carried into Lake Cayuga. The entire population evacuated the town. The village of Dryden nearby was under 6½ ft. of water and most of the business section was swept away when a dam collapsed.

Railroad service completely disrupted

Railroads serving the southern tier of New York counties reported considerable damage but could not arrive at definite figures because in many places water still covered the tracks.

The Lackawanna Railroad, the main line of which runs through the afflicted area to Buffalo, reported bridges out at Bath and Painted Post, where water is reported to have been 5 ft. deep. Water made a definite check of the damages impossible. Service between Bath and Elmira was at a standstill. Trains could not be detoured by way of the New York Central as the Pennsylvania division of that line was also considerably damaged.

For a distance of 40 mi. from Hornell to Corning, where water reached a depth of 5 ft., service over the Erie Railroad was completely disrupted as the roadbed was washed out for practically the whole distance. No bridges were washed out, but abutments were undermined and tracks and yards were covered with water and debris. The branch to Painted Post was also out of service.

On the Lehigh Valley road the Ithaca branch suffered the worst washouts and although no bridges were carried away there was extensive damage to culverts. Water was reported to be still covering the tracks in many places. Some trains were rerouted over the New York Central.

Extensive damage was done to the state canal system, largely by heavy deposit of silt. Sweeper boats were sent out to keep the channel clear.

Chemung River discharge

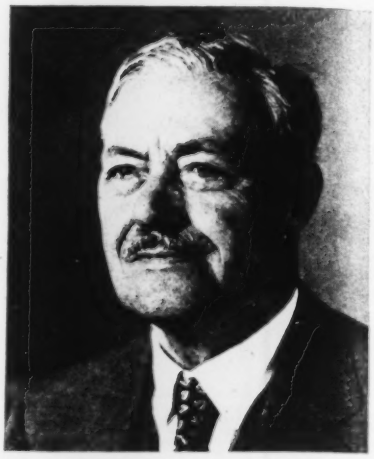
A telegraphic report from Colus C. Hunter, consulting engineer, at Elmira, states that the Chemung River was receding at 4 p.m. Tuesday. Although the river reached a height and volume equalled only by the great flood of June 1, 1889, when traffic and other conditions were vastly different, the river rose 4 ft. in the 10-hr. period before 1 a.m. Tuesday. "The Chemung River," states Mr. Hunter, "drains an area above the city of Elmira of about 2,055 sq.mi.; the flow for the past 18 hr. has averaged 138,000 sec.-ft. at an estimated rate of run-off of 67 sec.-ft. per sq.mi. The flow has been entirely confined to the stream channel without a break of any importance at any point."

At the time of going to press, the floodwaters, augumented by new rains, were causing the Schuylkill, Susquehanna and Delaware rivers in Pennsylvania to leave their banks.

YARDS OF ERIE RAILROAD at Hornell, N. Y., on the Canisteo River, one of the towns hardest hit by this week's floods.

A. F. Reichmann Vice President Of American Bridge Co.

Albert F. Reichmann, assistant chief engineer, American Bridge Co., and in charge of engineering in Chicago, has been



Albert F. Reichmann

elected vice president of the company effective July 1, after 34 years of service with the company. His office remains in Chicago. Mr. Reichmann, who after a high school education in Chicago obtained his technical training in Karlsruhe, Germany, was employed with the Lassig Bridge & Iron Works in Chicago for some years and then became assistant engineer in charge of the designing office of the bridge and building department of the Chicago Milwaukee and St. Paul Ry. Co., where he remained from 1894 to 1901. His service with the American Bridge Co. has been continuous since the latter date. He was a director of the American Society of Civil Engineers from 1929 to 1931.

Changes in PWA Procedure Planned to Speed Projects

New methods of speeding up PWA procedure were discussed at conferences in Washington this week with state directors. The principal short-cut will be a new contract which consists merely of an offer by the applicant for a non-federal project and acceptance by PWA. This will be a uniform printed form with only such variations as may be necessitated by local conditions.

PWA state offices have now been completely staffed with trained men previously on duty in Washington. All applications are given a thorough examination by them and forwarded to Washington with a recommendation for approval or disapproval. When reviewed and approved at Washington headquarters, the applications are referred to the Works Progress Administration for a check with reference to the labor required, together with the labor available in the locality. From PWA the application is forwarded to the Division of Applications and Information and then to the Advisory Committee on Allotments which submits it with its recommendation to the President. Regulations outlining the procedure after approval of a project are close to final form and will be issued soon.

(Continued from p. 64)

together with continuing allotments for federal and non-federal projects, highway construction, grade-crossing elimination, rural electrification and so on are expected to absorb each state's quota of the $4,000,000,000 fund as determined by the number of employables on their relief rolls. The cost of huge federal projects, such as the Fort Peck dam in Montana, which cannot properly be charged in its entirety against the quota of the state in which it is located, will be "capitalized at $1,140 per man employed and that figure charged against the state's quota."

The WPA programs originally submitted for Indiana, Georgia, Alabama, New York City and the District of Columbia were stripped of numerous projects over $25,000 in cost which the President has referred to PWA because he felt that the local contribution should be greater than that which the sponsors proposed to give under WPA. The WPA programs approved for New York City and Washington, D. C., do not require any local contribution. The totals, in thousands of dollars, are as follows:

	Federal Contribution	Local Contribution
Indiana	$29,640	$6,296
Georgia	10,398	3,311
Alabama	8,631	2,348
New York City	77,689	None
District of Columbia	1,236	None
Totals	$127,594	$11,955

WPA work is of many types but road projects predominate. Out of Alabama's total, for example, more than half is for county road and bridge construction. Such road work is independent of highway construction covered by the $200,000,000 allotment already made from the relief works appropriation. Regulations governing the highway program, now on the President's desk, will require that 37½ per cent of each state's quota must be spent on secondary roads.

Normal budget work not eligible

Local authorities are invited to submit project proposals to WPA district offices but these should not include work that is normally covered in their regular budgets. Whether WPA or local officials will conduct construction will depend on the project, the size of the local contribution and other factors. Labor will be requisitioned by the local works progress managers from the nearest office of the U. S. Employment Service. On receipt of an order specifying the number and kind of workers needed, the employment office will select from registrants those whose qualifications appear to fit the jobs and refer them to the foremen of the projects. All men must be from relief rolls and must be registered at the local employment offices, as no other unit has authority to assign workers to the jobs.

Hours and pay

Eight hours in any one day and 70 hours in any semi-monthly period have been established as maxima. The actual number of working hours per day on any project or class of projects will be determined by Hopkins at the time of his approval or in such other manner as he may designate. Workers will be paid by check from the state works progress administrators, in accordance with the previously announced regional schedules for common, intermediate and skilled workers. Deductions will be made for time lost because of voluntary absence, illness, postponement or completion of a project, or permanent dismissal. Any disbursements made by the local sponsors of a project will be regarded as a contribution, and no reimbursement will be made.

Centralized purchasing limited

WPA is planning to centralize materials purchases by districts, of which there are approximately 320. The scheme which President Roosevelt had in mind for centralizing the purchase of all equipment and materials needed in the relief works program is being studied by the Procurement Division of the Treasury Department, but little progress has been made. It will not apply to either WPA or PWA, nor to the Corps of Engineers. The practicability of its application to the Rural Electrification Administration, to the PWA Housing Division and the Rural Resettlement Administration is being studied.

Peru Opens New Road From Lima to Oroya

A new highway, extending 111 mi. from Lima, through the mountains of central Peru, to Oroya, was opened to traffic on July 1.

The road, which was begun in February, 1932, and which has cost about $2,500,000, has an average width of about 20 ft. There are 24 bridges on the road which reaches an elevation of 14,540 ft. at Anticona. At Oroya the road connects with 870 mi. of highway and is expected to greatly benefit agriculture and mining in the central part of Peru. This mountainous section has hitherto depended on railroad transportation.

Commerce Department Plans Extensive Airport Program

Plans for an extensive airport program under the Bureau of Air Commerce, Department of Commerce, have been revealed in an application for $58,759,000 from the relief works program. So far the application has only been received by the Division of Applications and Information and no announcement has been made of its approval.

Under the proposed program airports which have been started by the CWA will be carried to completion, new airports will be built and existing airports will be modernized by using such new equipment as radio approach landings. In discussing the policy to be followed, Secretary Roper said that no work will be done on leased or rented land regardless of the length of the lease. Only if a municipality owns or acquires title to the necessary land will its application be accepted. Under the terms of the Air Commerce Act of 1926 the Department of Commerce cannot own or lease land used for the carrying on of regular flying, but it can and will lease land for the establishment of emergency landing fields.

There are a number of airports on which work was done under the CWA and which are still incomplete. If the towns in which these are located acquire the land, and if they have a population of more than 10,000 their applications will be accepted by the Bureau of Air Commerce.

The Department of Commerce has not yet prepared a complete list of the projects on which the money, if obtained, is to be spent. The breakdown of the fund into the various allotments will depend upon which municipalities qualify.

OLD STONE VIADUCT HAS WITNESSED A CENTURY OF RAILROAD PROGRESS

Thomas Viaduct, which was opened to traffic on July 4, 1835, celebrated 100 years of service last week by carrying the Royal Blue, the new streamlined steam train of the Baltimore & Ohio Railroad. The little Atlantic locomotive, also shown, was one of the first to run across the bridge, which is on the Baltimore-Washington division of the B. & O. The viaduct crosses the Patapsco River from Elkridge to Relay, near Baltimore, Md.

The old stone-arch viaduct was constructed at a cost of about $140,000 and was named after Philip E. Thomas, first president of the B. & O. Built on a 4-degree curve, the bridge, which is 612 ft. long, consists of eight elliptical arches with clear openings of about 58 ft. It rises 60 ft. above the river. Except for routine maintenance the bridge has not been changed since it was built; all of the stones are said to be in their original locations.

Washington Highlights

By Paul Wooton

With the Wagner Labor Disputes Act on the statute books there is now little chance for the 30-hour bill or any compromise that might be based on that measure. For a time there was a chance that the measure might be put through on a 36 or 40-hour basis.

Thorough-going tax revision may grow out of the inheritance and income tax recommendations of the Administration. There is growing sentiment in Congress for substantial reduction of the deficit through increased taxes as well as by scrutiny of outgo. All money raised by the taxes proposed by the President is to be definitely earmarked for the reduction of future borrowing and the paying off of the public debt.

Conditions under which national banks may make real estate loans were liberalized greatly in the banking bill passed by the House, but the Senate committee was not willing to go that far. It restored the restriction that loans must be made within the federal reserve district and the provision that loans may not exceed fifty per cent of the appraised value of the real estate. The House removed the geographical limitation and allowed loans up to sixty per cent of value. The House leaves the conditions of real estate loans largely to the judgment of the Federal Reserve Board but the Senate restricted the term to five years except when installment payments will reduce the principal fifty per cent within ten years. Such a loan may be sixty per cent of the appraised value. While the Senate provisions are somewhat more liberal than the existing law, some compromise between the Senate and House provisions likely will result in conference.

Expenditure of not to exceed $100,000,000 for reclamation projects has been recommended by the relief works allotment board. This includes $38,000,000 already approved for dam structures.

Washington, July 8, 1935.

American Society of Draftsmen Incorporated in California

In the early part of January, this year, draftsmen representing private industries and governmental agencies met in Los Angeles and after several preliminary meetings organized as the American Society of Draftsmen. This organization is the outgrowth of a feeling among them that they should have a representative body of their own which would sponsor their work in its many diversified forms.

The sponsors of this movement believe that drafting should be recognized as a distinct profession in itself and have laid down the following as among the aims and purposes of the society:

1. To elevate drafting to a profession through a program of constructive activities.
2. To become national in scope, by establishing chapters in as many localities as possible.
3. To protect and improve the ethics of the drafting profession.
4. To establish a placement bureau for draftsmen seeking employment.

SOCIETY CALENDAR

INSTITUTE OF TRAFFIC ENGINEERS, sixth annual meeting at Louisville, Ky., October 15-16.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Miami, Fla., December 9-12.

NEW ENGLAND WATER WORKS ASSOCIATION, fall convention, Providence, R. I., Sept. 17-20.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS at a recent meeting elected the following officers: president, L. F. LIVINGSTONE; vice-presidents, M. L. NICHOLS and G. W. KABLE; secretary-treasurer, RAYMOND OLNEY.

Personals

WILLIAM R. REYNOLDS, Watertown, Conn., has been appointed projects engineer of the Connecticut Works Progress Administration.

J. S. HAZELTON, who had been stationed at Roaring River State Park, Cassville, Mo., has been assigned as construction engineer on dam work in Sam A. Baker State Park, Piedmont, Mo.

ROBERT LINTON has resigned his position as vice president and general manager of Pacific Clay Products Co., to engage in practice as consulting engineer in Los Angeles, Calif.

FREDERICK H. FOWLER, consulting engineer of San Francisco, Calif., has been retained to make a comprehensive study of flood protection in the lower Kaw River Valley near Kansas City, Mo.

L. W. HICKEY, who has been serving with the Code Authority for the Contracting Industry has concluded his work in Washington and is returning to Dallas to devote his entire time to the affairs of Hickey and Co.

LT. COMDR. ROBERT E. BASSLER, CEC, U. S. Navy, has been ordered from duty as public works officer of the Fleet Air Base, Coco Solo, C. Z., to duty in the Third Naval District, with headquarters at New York City.

LT. COMDR. FREDERICK R. HEWES, CEC, U. S. Navy, has been ordered from duty at the Naval Air Station at Sunnyvale, Calif., to the Fleet Air Base, Coco Solo, C. Z., as public works officer.

LT. COMDR. WILLIAM W. SCHNEIDER, CEC, U. S. Navy, has reported for duty as public works officer of the Submarine Base, Coco Solo, C. Z., his previous duty being in the Mare Island, Calif., Navy Yard.

EMORY W. LANE, research engineer, U. S. Bureau of Reclamation, has been appointed Professor of Hydraulic Engineering at the University of Iowa. Mr. Lane is a graduate of Purdue University and of Cornell. He has had extensive experience in hydraulic engineering with the Morgan Engineering Co., with the U. S. Rivers and Harbor Board, the U. S. Engineer Corps, the St. Lawrence Waterway Board, and the Bureau of Reclamation. He was manager of the China branch of the Morgan Engineering Co. in 1920-23, and engaged in work on the Grand Canal and Yangtze River.

Brief News

PURCHASE BY THE BOSTON METROPOLITAN DISTRICT COMMISSION of the Moody Street dam on the Charles River at Waltham, Mass., has been recommended in a report filed in the Massachusetts house of representatives by the ways and means committee. The bill provides for an appropriation of $35,000 to permit regulation of the water so as to avoid exposing the river bottom during dry periods.

WORK ON THE McARTHUR (O.) WATERWORKS and sewage system has been indefinitely suspended. The suspension was caused by a protest against the hiring, by the contractor, of four non-local men to operate machines, instead of obtaining skilled labor from the local reemployment service.

RECISION OF AN ALLOTMENT of $24,000,000 to the Allegheny County (Pa.) Authority hangs on an investigation ordered by Administrator Ickes into the cause of delay in undertaking bridge, tunnel and related projects in the Pittsburgh area.

FORMATION OF A SEWER IMPROVEMENT COMMITTEE has been authorized by the Little Rock, Ark., city council. The committee will engage civil engineers to aid in making a preliminary survey of the sewer needs. It is planned to construct a trunk line sewer from the western part of the city to the Arkansas River and tie all existing lines into the trunk line instead of emptying the sewage into Fourche Bayou.

Obituary

JESSE C. PATRICK, who had been assistant chief of the Albany, N. Y., department of public works, died at his home there on June 25 at the age of 62. Mr. Patrick began his engineering training in Mexico and served for many years in the Panama Canal Department.

NICHOLAS T. COSTELLO, 63, assistant engineer in the city engineering bureau, Buffalo, N. Y., for 35 years, died June 27, at his home in that city. Mr. Costello was a graduate of St. Joseph's Collegiate Institute, and Canisius College. He was a consultant on the construction of the municipal pumping station and water intake.

ARTHUR KRAUSE, who had been chief architectural engineer for the American Sugar Refining Co. until his retirement in 1917, died at his home in Mountain Lakes, N. J., on July 2 at the age of 83. Mr. Krause, who was born in Germany, was educated in the New York public schools, after which he entered the engineering profession. At the time that Central Park was being laid out in New York City he was employed as head draftsman for the development, and later became associated with the American Sugar Refining Co.

ANDREW WHITNEY WOODMAN, consulting civil engineer and manufacturer, Chicago, died July 1 in Evanston, Ill. Born in 1866 in Gardner, Mass., he was graduated in civil and mechanical engineering from Massachusetts Institute of Technology in 1890 and served for the next seven years with the Boston Bridge Works. He

then became district manager for Roebling Construction Co., and went to Chicago in 1905. From 1909 to 1914 he was a contracting engineer and later became president of the Joliet Bridge and Iron Co. In 1921 he purchased the National Steel Bank and Manufacturing Co. For the last several years he maintained a consulting office.

GEORGE KELLER, 92, died at his home in Hartford, Conn., July 7. Mr. Keller, who had retired from active practice in 1914, was the designer of the Gettysburg Memorial, where Lincoln made his famous address. He also designed the Garfield National Memorial in Cleveland and the monumental gateways at the soldiers' homes at Danville, Ill., and Dayton, Ohio.

CLETUS THOMAS HAYES, who had been chief of the Philadelphia bureau of water for the last seven years, died in Germantown, Pa., on July 7 at the age of 47. Before becoming a member of the bureau of water, Mr. Hayes, a graduate of Villanova College, had been an engineer for the Central Railroad of New Jersey and various construction firms. While associated with the Keystone State Construction Co., he was in charge of engineering on a section of the North Broad St. subway in Philadelphia. Mr. Hayes later became construction engineer for the bureau of water and in 1928 was appointed chief of the bureau.

WILLIAM W. WYSOR, chief engineer of the United Railways & Electric Co., Baltimore, Md., died at his home there on June 30, at the age of 57. Mr. Wysor graduated from the Virginia Polytechnic Institute in 1899. His first position was with the Virginia & Tennessee Telephone Co. Later he became associated with the Virginia & Southeastern Railway and then with the Norfolk & Western Railroad as transit man. Following this he became mining engineer for the Crane Creek Coal & Coke Co. and was in charge of field work in West Virginia. Returning to the Norfolk & Western, Mr. Wysor became assistant engineer in charge of surveys and construction work in the coal fields. In 1904 he was transferred to Lynchburg, Va., to take charge of the construction of a belt line around Lynchburg. In 1908 Mr. Wysor was made chief engineer of the Chattanooga Railways Co. and the Lookout Mountain Railway. He later went to Allentown, Pa., as chief engineer of the Lehigh Valley Transit Co. In 1917 he became chief engineer of the United Railways & Electric Co.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING construction awards for the week total $17,913,000 of which $12,332,000 is for state and municipal, $1,351,000 federal and $4,230,000 private. All three classes are lower than last week which represented only a four-day week. For the corresponding week last year the totals were $14,776,000 for state and municipal, $1,516,000 for federal and $2,415,000 for private.

Earthwork, irrigation and waterways awards are higher at $4,663,000; streets and roads at $4,241,000 and sewers at $990,000, but all other classifications are lower. Federal awards at $1,351,000 are the lowest this year.

The larger projects include highway work by Washington, $596,000 and by New Mexico, $336,000. The State Water Power & Control Commission of New York will reclaim the Walkill River and Valley to include widening, deepening and straightening the river at an estimated cost of $4,000,000. Work will be done by the CCC.

State and municipal bond sales for the week total $1,873,000. Allotments from the old PWA fund are non-federal loans, $570,000, and federal construction, $70,000. From the new fund the President has approved federal allotment of $184,000 for the Bureau of Yards and Docks, U. S. Navy, and for slum clearance and low cost housing, $69,985,000. The RFC has approved loan of $36,000,000 to Metropolitan Water District of Southern California which is being advanced at the rate of three or four millions monthly in interim certificates to be covered by bonds eventually. The whole amount has been included in the new capital total.

CONTRACTS

(Thousands of Dollars)

	Weekly Average July 1934	Prev. 4 Weeks	Week July 11 1935
Federal Government	$10,224	$6,421	$1,351
State and municipal	14,816	12,188	12,332
Total public	$25,040	$18,609	$13,683
Total private	4,450	8,870	4,230
Week's total	$29,490	$27,479	$17,913
Cumulative to date:			
1934...$745,217,000	1935...$694,613,000		

NEW PRODUCTIVE CAPITAL

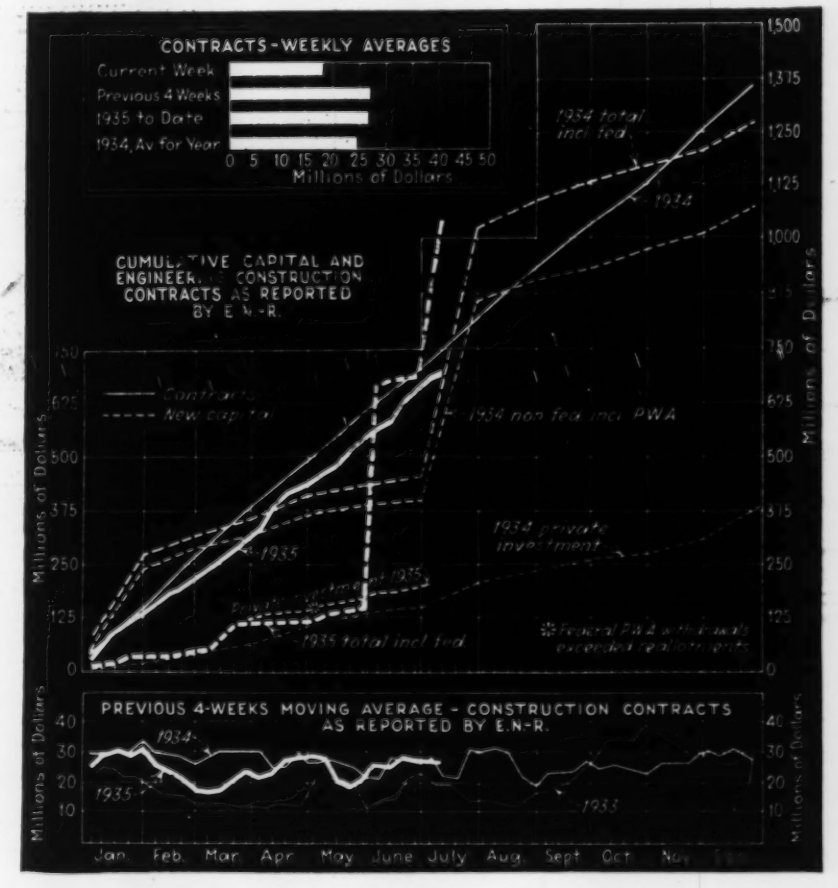
(Thousands of Dollars)

1935	Week July 11	Cumulative
State and municipal	$1,873	$202,812
PWA allotments, S&M	94,985	180,250
RFC loans, S&M	36,000	36,084
Corporate issues	.....	.....
PWA allotments, private	570	8,629
Total, Non-Federal	$133,428	$427,775
PWA allotments, Federal Constr.	254	617,989
Total new capital	$133,682	$1,045,764
Cumulative to date:		
1934..$882,985,000	1935..$1,045,764,000	

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for Federal construction. Negative amounts in PWA totals indicate excess of rescissions and reductions over reallotments and increases in outstanding allotments.

INDEX NUMBER

E.N.R.-Cost	1913 = 100	1926 = 100	E.N.R.-Volume	1913 = 100	1926 = 100
July, 1935	**195.18**	**93.82**	**June, 1935**	**122**	**54**
June, 1935	194.78	93.63	May, 1935	109	48
July, 1934	199.65	95.97	June, 1934	119	50
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56


CONTRACTS - WEEKLY AVERAGES
Current Week
Previous 4 Weeks
1935 to Date
1934 Av for Year
0 5 10 15 20 25 30 35 40 45 50
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
Millions of Dollars
1934 total incl fed
1934
1934 non fed incl PWA
1934 private investment
1935
1935 total incl fed
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1934
1935
1933
Jan. Feb. Mar. Apr. May June July Aug. Sept Oct Nov

Current Construction Unit Prices

Average Prices on Kentucky Roads, '34-'35

HIGHWAY contract unit prices showed a 2.5 per cent increase for Kentucky state roads for the 12-month period ending March 31, 1935. This change is based on 61 principal items of which 35 alone reflect the net increase. The average costs for class A and B concrete show a 1.5 per cent rise, whereas those for class D show a decline over the 1934 units. The maximum increases occur in those items requiring a large proportion of labor as compared with material, such as for cleaning, grubbing, excavation and demolition. On the other hand some saving is shown on such items as corrugated metal and vitrified pipe, crushed limestone chips and slag. A comparison of the average units are given in the following table furnished by the Kentucky state highway department.

TWO-YEAR RECORD OF KENTUCKY HIGHWAY COSTS

	Ave. Prices for Year Ending Mar. 31, 1934	Mar. 31, 1935
1. Clear and grub—acre	$10.776	$11.254
2. Remove trees and stumps—each	2.798	5.819
3. Excavation, roadway & drainage, unclassified—cu.yd.	0.337	0.322
4. Excavation, borrow, unclassified—cu.yd.	0.207	0.305
5. Excavation, structure, unclassified—cu.yd.	1.058	1.088
6. Excavation, trench & shoulder, unclassified—cu.yd.	0.199	0.182
7. Removing pipe—lin.ft.	0.299	0.328
8. Relay pipe—lin.ft.	0.339	0.346
9. Standard catch basin—each	46.481	50.556
10. Scarify and reshape—sq.yd.	0.020	0.033
11. Remove sidewalk—sq.yd.	0.367	0.184
12. Remove concrete masonry—cu.yd.	2.875	2.668
13. Remove stone masonry—cu.yd.	1.601	1.232
14. Remove headwalls—each	3.160	3.488
15. Remove existing structures—each	184.170	164.580
16. Corrugated metal pipe, 15 in.—lin.ft.	1.269	1.217
17. Corrugated metal pipe, 24 in.—lin.ft.	2.323	2.276
18. Vitrified pipe, 15 in.—lin.ft.	1.170	1.399
19. Vitrified pipe, 24 in.—lin.ft.	2.293	2.385
20. Reinf. concrete pipe, 15 in.—lin.ft.	1.075	1.102
21. Reinf. concrete pipe, 24 in.—lin.ft.	2.334	2.226
22. Vitrified pipe, 18 in., cross drainage—lin.ft.	1.482	1.408
23. Vitrified pipe, 24 in., cross drainage—lin.ft.	2.569	2.394
24. Reinforced concrete pipe, 12 in., cross drainage—lin.ft.	1.050	1.261
25. Reinforced concrete pipe, 15 in., cross drainage—lin.ft.	1.250	1.262
26. Reinf. concrete pipe, 18 in., cross drainage—lin.ft.	1.446	1.471
27. Reinf. concrete pipe, 24 in., cross drainage—lin.ft.	2.443	2.468
28. Reinf. concrete pipe, 36 in., cross drainage—lin.ft.	4.704	5.000
29. Reinf. concrete pipe, 48 in., cross drainage—lin.ft.	9.000	
30. Concrete, Class A—cu.yd.	15.088	15.317
31. Concrete, Class B—cu.yd.	14.228	14.544
32. Concrete, Class D—cu.yd.	37.318	36.416
33. Stone masonry, First Class—cu.yd.	8.293	10.701
34. Stone masonry, culvert—cu.yd.	7.428	8.07
35. Stone paving—sq.yd.	1.905	1.599
36. Riprap—sq.yd.	1.396	1.376
37. Reinforcing steel—lb.	0.0369	0.0385
38. Structural steel—lb.	0.0452	0.0473
39. Bronze expansion plates—lb.	0.287	0.297
40. Piling, timber, treated—lin.ft.	0.889	0.832
41. Piling, precast concrete—lin.ft.	2.124	2.739
42. Lumber, treated—M b.m.	85.369	107.45
43. Crushed limestone—ton	1.572	1.577
44. Crushed sandstone—ton	1.470	1.300
45. Coarse aggregate for surface mix—ton	2.517	2.214
46. Crushed limestone chips for surface mix—ton	2.640	2.260
47. Gravel—ton	0.759	0.802
48. Rock asphalt—ton	10.330	10.940
49. Concrete base for high type paving—sq.yd.	1.450	1.776
50. Reinforced concrete paving—sq.yd.	1.575	1.694
51. Light oil—gal.	0.0889	0.094
52. Asphalt cutback—gal.	0.0989	0.101
53. Header curb—lin.ft.	0.416	0.343
54. Concrete curb and gutter—lin.ft.	0.989	0.924
55. Concrete sidewalk—sq.yd.	1.609	1.552
56. Concrete valley gutter—lin.ft.	1.318	1.438
57. Asphalt cutback, paint coat—sq.yd.	0.0396	0.020
58. Removing curb and gutter—lin.ft.	0.080	0.123
59. Crushed slag—ton	3.050	2.370
60. Sheet asphalt binder—ton		7.217
61. Modified Topeka mix—ton		5.80

Dover Dam, Tuscarawas River, Ohio

WORK on the Dover Dam on the Tuscarawas River, 3½ miles from Dover, Ohio, started in May, 1935, with the award of contract for the construction of a dam of the massive concrete straight gravity type. The project forms part of the Muskingum watershed conservancy program. The dam has a top length of 820 ft. and a height of 80 ft. above foundation in the maximum section. The spillway section will be 338 ft. long with abutment sections on either side 15 ft. higher than the spillway crest. Eighteen conduits, having twelve 7x7-ft. and six 5x10-ft. oil pressure operated service gates, will control the river flow. A full width apron will extend downstream 187 ft. from the axis of the dam. The government furnishes f.o.b. job railroad siding, cement, service gates complete with operating machinery, emergency gates and accessories, traveling crane for operating house superstructure and the trolley and electric hoist for the gallery.

Eleven bids ranged from the contract low of $957,262 to a high of $1,588,405. The following tabulation lists the quantities with the unit prices and totals of the three low bidders. A—Bates & Rogers Coast Co., Chicago (contract), $957,262; B—York Eng. & Const. Co., York, Pa., $996,491; C—Geo. M. Brewster & Son, Inc., Bogota, N. J., $1,143,371. Major J. D. Arthur, Jr., is the district engineer in charge for the Corps of Engineers.

DOVER DAM, TUSCARAWAS RIVER, OHIO

	A	B	C
1. Diversion and care of river during construction—total	$45,000.00	$30,000.00	$137,000.00
2. Remove existing structures—total	490.00	500.00	6,000.00
3. Clear reservoir areas—total	32,000.00	14,000.00	20,000.00
4. Common excavation—112,000 cu. yd.	.40	.50	.64
5. Rock excavation—28,000 cu.yd.	2.00	.75	3.00
6. Rock excavation, trenches—9,000 cu.yd.	2.85	4.00	4.00
7. Rock channeling, close drilling, broaching—27,000 s.f.	.90	.65	.60
8. Hunt Bx 100 (or similar) process treatment (each coat)—300 squares	1.30	5.00	3.20
9. Rolled embankment—28,700 cu. yd.	.50	.50	.37
10. Rockfill—12,000 cu.yd.	.33	.40	.67
11. Compacted backfill—31,000 cu.yd.	1.00	.75	.62
12. Uncompacted backfill—9,000 cu. yd.	.25	.25	.35
13. Top soil—750 cu.yd.	1.00	1.00	1.50
14. Seeding—0.55 acre	500.00	100.00	520.00
15. Sand and gravel filters and drains—900 cu.yd.	4.65	2.00	5.00
16. Riprap—800 cu.yd.	2.65	3.50	4.35
17. Rock paving in gutters—100 cu.yd.	5.30	8.00	4.21
18. Gravel road surfacing—900 sq.yd.	1.30	.90	.85
19. Haul and store cement—124,000 bbl.	.12	.10	.125
20. Furnish, bend, place steel reinforcement—1,175,000 lb.	.038	.045	.035
21. Drill holes, 2 in.—5,000 lin.ft.	1.50	1.25	1.50
22. Drill holes, 3 in.—4,200 lin.ft.	1.75	1.50	1.60
23. Drill holes, 6 in.—330 lin.ft.	6.00	6.00	6.00
24. Drill 6 in. holes in concrete—100 lin.ft.	7.00	7.00	6.00
25. Pressure grouting—8,000 cu.ft.	1.30	1.00	.83
26. Concrete in dam and appurtenant structures—102,000 cu.yd.	4.75	5.50	5.00
27. Concrete, outside stairway and railing posts—200 cu.yd.	33.20	15.00	40.00
28. Install gates and accessories—1,675,000 lb.	.02	.02	.016
29. Grout gate recesses—800 cu.yd.	8.80	15.00	15.00
30. Furnish, install oil pressure system—28,300 lb.	.13	.30	.70
31. Install crane, trolley, electric hoist—11,600 lb.	.03	.035	.03
32. Furnish, install automatic sump pump in gallery sump—one	90.00	175.00	500.00
33. Furnish, install misc. structural steel—26,000 lb.	.08	.08	.12
34. Furnish, install misc. metal work—101,000 lb.	.08	.14	.20
35. Furnish, install W.I. pipe—9,500 lb.	.25	.20	.20
36. Furnish, instal misc. black steel pipe—64,900 lb.	.12	.13	.15
37. Furnish, install misc. brass and bronze—300 lb.	1.30	.60	1.50
38. Furnish, install copper water stops—5,700 lb.	.35	.50	.85
39. Highway guard rail—200 lin.ft.	1.05	.75	1.50
40. Conduits for electric wiring—6,700 lb.	.35	.40	.40
41. Furnish, install light and power system, and accessories—total	3,960.00	5,000.00	3,600.00
42. Operating house, north abutment—total	7,500.00	13,500.00	7,335.00
43. Entrance house, south abutment—total	2,600.00	3,500.00	1,985.00
44. Field office—total	2,800.00	2,500.00	5,000.00
45. Furnish oil, and fill oil system—4,400 gal.	.65	1.00	.37